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THE MAPLIN MAGAZINE
ELECTRONICS and Beyond
February 1999 Vol. 18 No. 134

Projects

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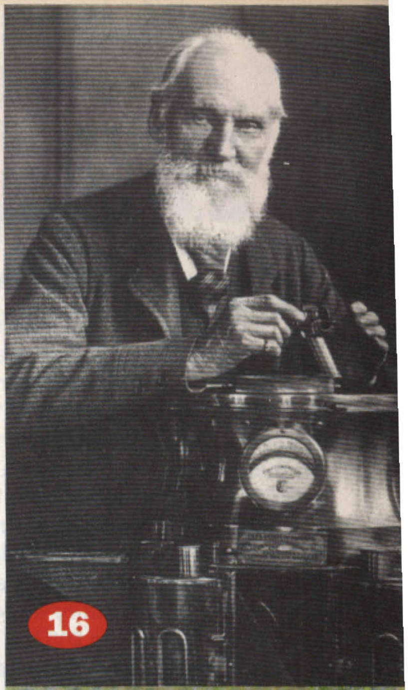
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50

ELECTRONICS and Beyond

As we enter the last year of the twentieth century, one can only look back at the last 20 years to perhaps wonder at the rate of progress in the world of electronics. At the beginning of the 80s we had microprocessors running at around 1MHz, yet this year we expect to see the first 1GHz device – a 1000 fold increase in speed!. In the world of audio and video there has been a similar explosion in digital technology. We have virtually lost the vinyl record to the CD and it is quite likely that within the opening years of the 21st century we will loose analogue video recorders to the DVD or a derivative. Plus, we now have digital radio and television and even 'digital' loudspeakers are now a real possibility (see News Report). The transition to a digital world is certainly taking off and living up to expectation.

This month we look at flat screen displays, and do a quick review of a new DVD player from Maplin. With this level of technology, and the introduction of large screen displays, perhaps another casualty for the 21st century will be the local cinema.

Also this month, Douglas Clarkson looks at the life of Lord Kelvin, an eminent scientist and engineer, who at the end of the 19th century was playing his part in the shaping of scientific thinking for the 20th century. Today, it is not so much individuals, with perhaps a few exceptions (Bill Gates?), but multinational companies that broaden our scientific horizons. With such rapid technological advances, the 21st century certainly promises some very exciting developments.

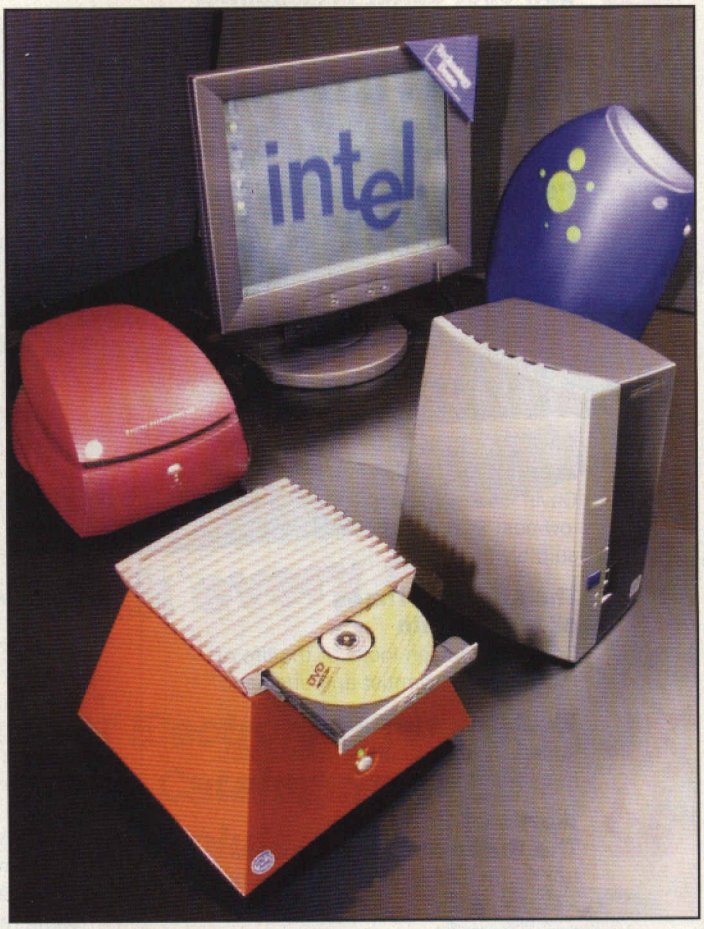
Congratulations

To Mark Morris of Woking, Surrey, the winner of the Maplin/Demon PC competition from the November issue who will be receiving a top end PC. Well Done and happy surfing!

Finally, may we wish all our readers a prosperous and happy new year.

PLease look through our FREE catalogue for some real bargains!

NEWS REPORT



Information Appliances Finally Arrive?

Intel is pushing a new concept in PCs – a PC that doesn't look like a PC at all. It's more like an orange and silver pyramid without a top. And inside, it's different, too, relying on 'plug-and-play' universal serial bus ports rather than the old industry standard architecture sockets that require users to install circuit boards or load software every time they add a peripheral component.

The PC, code-named Aztec, hasn't and won't be built by Intel, but the company is hoping to use its influence to persuade PC makers to adopt its vision of simpler, more stylish devices that work more like information appliances.

For further information, check: <www.intel.com>.

Contact: Intel, Tel: (01793) 403000.

Memory Stick is Future of Memory

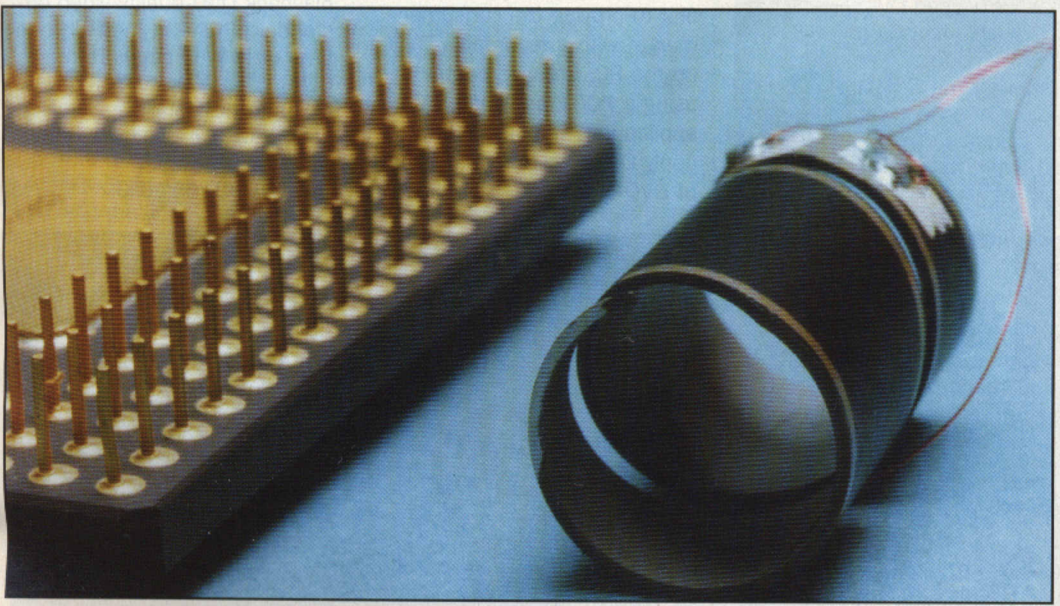
A miniature storage device developed by Sony Electronics and called the Memory Stick, could become a key building block for the next generation of convergence products. To demonstrate Memory Stick's versatility in enabling new applications, engineers integrated the device into a dazzling array of futuristic technologies at Comdex last month in Las Vegas.

The concept mock-ups include cellular and home telephones, 'photo stands' for displaying digital images, LCD TVs and digital set-top boxes, intelligent remote controls and voice recorders, Walkman personal portable stereos and headphones, ultra-compact notebook computers, desktop stations, and car navigation systems.

For further details, check: **<www.sony.co.uk>.**

Contact: Sony Electronics, Tel: (0990) 111999.

Electronic Spring Basis of Digital Loudspeaker



1... Limited, the British company pioneering the development of digital loudspeakers has announced a breakthrough in the development of its digital loudspeaker (DLS) technology.

Working with its technology partner, the University of Birmingham Interdisciplinary Research Centre (IRC) for Materials, 1... Limited has defied electronic and mechanical conventions to create an electronic spring, termed a helical PZT ceramic bender. A working full-scale device has now been fabricated and is undergoing testing.

The electronic spring device contracts and expands when a voltage is applied, providing the basis for a motor-like transducer. Up until this point it was thought impossible to manufacture a multi-layer ceramic device in a helical arrangement.

1... Limited's new transducer will consist of just three parts: the outer helical bender, an inner cylindrical piston made of extremely low density material, and a gas-filled bearing between the two which allows the piston to move freely along the axis of the helix with essentially zero friction.

In operation, the cone-like deformations of the helical bender squeeze the gas bearing radially, which in turn imparts axial forces to the piston which rolls on the bearing up and down the centre of the helix, up to 10mm in either direction.

For further details, check: **<www.uno.to>**.

Contact: 1/4 Limited, Tel: (01223) 575398.

NEWS BYTES

Windows NT in Transition

While Windows NT continues to gain ground in European companies, it is still mainly used for office automation and file-and-print applications, and emerging for business applications, according to a new European survey by IDC.

User intentions to migrate their core business applications currently running on S/390, Unix, or OS/400 to NT are still modest, says the IDC study, 'The Challenge of NT's Transition from Office to Enterprise'.

For further details, check: **<www.idc.com>**.

Contact: IDC, (0181) 987 7100.

Oracle and Symbian Enter Enterprise Data Alliance

Oracle and Symbian have announced a strategic relationship to bring an extensive range of mobile enterprise computing solutions and services to the rapidly growing wireless market.

Symbian, a joint venture between Psion, Ericsson, Motorola and Nokia, will work with Oracle to enable the EPOC operating system to provide real-time, wireless access to data residing in Oracle databases – enabling EPOC based devices to deliver world-class solutions to enterprise customers.

For further details, check: <www.symbian.com>.

Contact: Symbian, Tel: (0171) 208 1800.

A3 Colour Printer from Canon

Canon has launched the latest model in its award-winning range of colour Bubble Jet printers. Priced at £270, the BJC-5000 is an A3-capable printer offering dual cartridge technology. This combines high-speed printing, 1440 dpi resolution, and laser-like text quality.

The new printer is a stand-alone Windows 95/Windows 98 printer capable of handling paper sizes from A5 (148 x 210) through to A3 (297 x 420 mm), as well as specialist media such as banner, transparency and fabric sheets.

For further details, check: **<www.canon.co.uk>**.

Contact: Canon, Tel: (0121) 666 6262.

Get Digital for Christmas

Dixons and MGI are giving away a free copy of MGI PhotoSuite II, the award-winning PC photography software, with every digital camera over £300 purchased in Dixons, Currys or PC World stores in the run up to Christmas.

For further details, check: <www.mgisoft.com>.

Contact: Dixons, Tel: (0900) 500049.

NEWS BYTES

Maplin Opens in Chester

Chester now has a specialist electronics store. Maplin opened the doors of its new 5,000 square foot facility last month at The Broughton Centre, Chester.

For further details, check: **<www.maplin.co.uk>**.

Contact: Maplin,
Tel: (01702) 554155.

IBM Reduces Laptop Prices

IBM Personal Systems Group has cut the price of its ThinkPad 380, 600 and 770 ranges of laptop PCs by up to 14%. In addition IBM also has the ThinkPad 390 – a new machine aimed at the small, very small, and medium business market.

For further details, check: <www.uk.pc.ibm.com/thinkpad.html>.

**Contact: IBM,
Tel: (0870) 6010136.**

Big Names Bet on Tut Technology

Big ticket high-tech companies, including Compaq, Lucent Technologies and Advanced Micro Devices, are licensing technology from start-up Tut Systems that uses telephone wires to create a household network.

For further information, check: **<www.tutsys.com>**.

Contact: Tut Systems,
Tel: +1 925 682 6510.

Microsoft Teams with Qualcomm for Wireless E-Mail

Microsoft and Qualcomm developer of the Eudora e-mail application, are starting a new company called WirelessKnowledge, which will focus on providing wireless data services to carriers, enabling them to offer customers seamless e-mail, Internet access and other computing functions via wireless phones and other handheld devices.

For further information, check: <www.qualcomm.com>.

Contact: Qualcomm, Tel: +1 619 587 1121.

Intel Says UK PC Prices are too High

Intel has accused Dixons of stunting PC sales in Britain by setting its prices too high Average PC prices in the U.K. are about a third higher than those in the US and Germany, according to figures from Context, a UK based research group.

For further details, check: **<www.intel.com>**.

Contact: Intel,
Tel: (01793) 403000.

Bug's Life' Available for Christmas

Sony has announced the release of Disney and Pixar's A Bug's Life – a 3D character game for the PlayStation game console.

Inspired by the Disney and Pixar animated feature of the same name, A Bug's Life offers a bug's eye view of the what critics are already calling the most incredible adventure game ever.

A Bug's Life features 15 fully interactive 3D game environments brought to life with lush scenery and lethal enemies. Combining new levels of cinematic quality animation with unique level design, A Bug's Life reflects the feature film experience.

For further details, check: **<www.playstation.co.uk>**.

Contact: Sony,
Tel: (0990) 111999.

C-Cube Delivers DVD Recording and Playback to Consumer PCs

In a striking move to enable the industry-wide adoption of DVD-quality video recording for consumers, C-Cube Microsystems has introduced DVxplore(TM), a single-chip consumer MPEG-2 and DV codec.

Supporting C-Cube in a unified vision for ease-of-use and proliferation of DVD-quality video on the PC and PC/TV platform, leading multimedia and PC product innovators Microsoft, Matrox, Creative Labs, and Ulead are endorsing DVxplore.

With DVxplore, C-Cube is the first to provide the consumer market with a recordable DVD on the PC. Creative people using a PC/TV and DVD-RAM applications will be the first to apply DVxplore to record hours of DVD-quality video obtained from any video source whether TV, VCR, DV camcorder or analogue camcorder. They will also be the first to edit and playback DVD-quality video on standard PCs and then store to DVD disk, Web pages, e-mail, CD-R/W or PC hard disk drives.

For further details, check: **<www.c-cube.com>**.

Contact: C-Cube,
Tel: (01293) 651100.

Reasons to Buy Digital TV

The Pace Report 1999, the annual review of the Digital TV industry from Pace Micro Technology, Europe's leading manufacturer of the set top boxes which enable digital television, has revealed the factors which consumers consider to be the most important in deciding to buy digital TV.

Consumers were asked to rate services and features according to their value, stating which reason would induce them to buy a digital TV. The improved quality of pictures and sound was found to be the most popular feature, with 73% of people considering the improvement to be of value. Of these, 20% believed that this alone would be the reason why they would subscribe to digital services.

Access to more information about the programmes being shown was the next favourite aspect, with 67% of respondents considering it valuable. Local news was also found to be very attractive to 66% of viewers. The increased number of programmes was cited as valuable by 64% of people, with 17% rating the improvement as the reason they would buy digital.

The ability to find out more about subjects being viewed (63%); improved access to local government/authority services (45%); interactive TV (42%), Internet access (39%) and home banking (38%) were all recognised for their value, and were cited as the main reasons to subscribe to digital by between 6-10% of interviewees. Home shopping and Impulse Pay Per View were also considered worthwhile by over a quarter of people (both 27%).

For further details, check: **<www.pace.co.uk>.**
Contact: Pace, Tel: (01274)

Sega Losing Sleep Over Dreamcast

If newsgroup reports are to be believed, Sega is having serious production problems with its new Dreamcast console, and will only be able to deliver 50% of its original target number for sales ahead of Christmas, with full production not starting until February.

But a small matter like the availability of products isn't stopping Sega from promoting its new platform. In Los Angeles this month punters took the plunge into 2,000 gallons of mashed potatoes in a bid to win the first Sega Dreamcast video game system and Sega Dreamcast games for life.

The Dreamcast game console, which is powered by a 128-bit chip, is critical to Sega's survival after its previous-generation product, the Sega Saturn, lost out big to Sony Playstation and Nintendo 64.

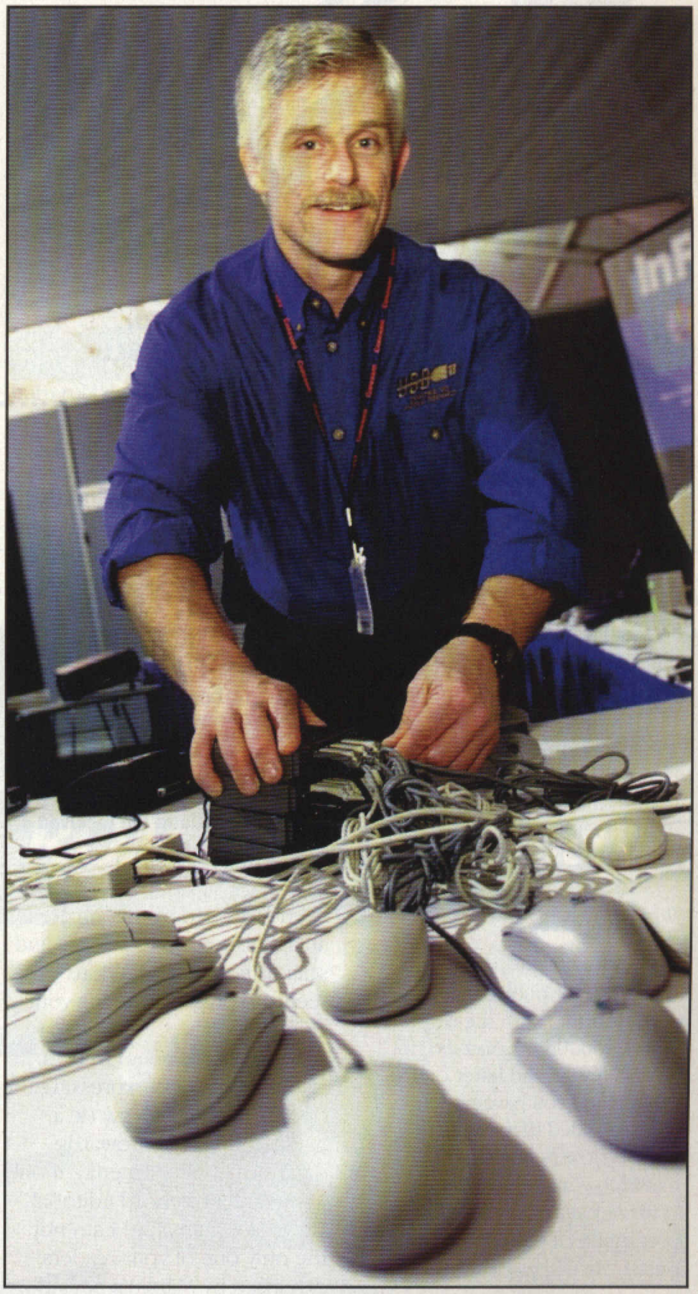
For further information, check: **<www.sega-europe.com>.**
Contact: Sega, Tel: (0181) 995 3399.

Cyrix Unveils WebPAD Concept Design

Cyrix has unveiled a reference design for a hand-held wireless Internet access device, dubbed WebPAD, based on a new version of the integrated MediaGX processor.

The WebPAD is the industry's first conceptual design for a low-cost, portable, wireless consumer device for Internet access. It allows users to effortlessly surf the Web or read and send e-mail from anywhere around the home or office.

For further details, check: **<www.cyrix.com>.**
Contact: Cyrix, Tel: +1 800 777 9988.



Intel Sets Peripheral Record

Intel set a record at Comdex last month, when it plugged over 100 computer mice into a USB hub during a demonstration. One hundred and eleven devices, including mice, joy sticks, printers and scanners, comprise the greatest number of peripherals ever attached to a PC by any method. USB provides computer users with a simple and user friendly way to connect peripherals while improving speed and performance.

For further details, check: **<www.intel.com>.**
Contact: Intel, Tel: (01793) 403000.

E-mail your views and comments to:
AYV@maplin.demon.co.uk

Write to: *Electronics and Beyond*,
P.O. Box 777, Rayleigh, Essex SS6 8LU

Cynical Ploy?

Dear Sir,

May I offer my apologies for a bout of cynicism when I saw the Free Novelty Christmas Tree PCB on your magazine cover this morning. As a hard-bitten engineer I immediately assumed that the project would need the latest 'Novelty Christmas Tree' IC fresh in from Velleman, complete with the sound of 15 badly digitised carols.

But, no – how wrong I was! On closer inspection the entire design seems to have been deliberately put together to be made from bits sitting in the spare parts box.

Within half an hour of scratting around for that last green LED, my tree twinkled into life when a battery was added to my home-made PP3 clip.

A friend's son got a start in electronics a few months ago by building the exact astable multivibrator circuit at school so there will be no doubt a few teachers interested in this elegantly simple project.

Thanks Maplin,
and Merry Christmas!

P.S. A length of mains 1mm² black neutral wire soldered in the top hanging hole makes a fine stand allowing the project to take its place in the living room. If only the real tree was this easy to put up!

James Derrick
Newcastle

Many thanks for the comments and the tip, and yes it was the intention that the Xmas Tree could be constructed from bits in the box if they were handy, or offer a bag of components at a very reasonable price if required. I have to say, I can not imagine anything worse than '15 badly digitised carols,' especially emanating from a tiny piezo sounder!

But I would like to mention, and plug at the same time, the range of simple and inexpensive kits that Maplin stock for the beginner, as an educational aid for youngsters on their first steps in electronics. We have discussed, several times in these pages, our concern at the lack of youngsters entering electronics as a career, and can only hope that such kits may help some of them follow the electronics path.

The Kodak Name

Dear Sir,

I must correct Mr. Frank H. Thomas on the origin of the name 'KODAK'. After some digging in the KODAK company web page you can find the following: .

It was in 1888 that the word Kodak was first registered as a trademark. There has been some fanciful speculation, from time to time, on how the name was originated. But the plain truth is that George Eastman invented it out of thin air.

He explained: "I devised the name myself. The letter "K" had been a favorite with me – it seems a strong, incisive sort of letter. It became a question of trying out a great number of combinations of letters that made words starting and ending with 'K. ' The word 'Kodak' is the result."

Inge O Hansen
Norway

Many thanks to Inge for that interesting update. We received a letter from John Draper of Kodak Ltd. who offered exactly the same explanation, and that it was published by George Eastman, himself, some 32 years after the trade mark was first registered. John Draper goes on to say that George Eastman never married, and that "... within the Corporation it is generally accepted that the explanation is that it comes from his mother's name, Kathleen. It is known that he was particularly grateful to his mother for bringing him up single-handed in difficult circumstances following the premature death of his father."

John Draper included with his letter a leaflet entitled 'How KODAK Got Its Name,' which had a fascinating first paragraph, which we reproduce here. Courtesy Eastman Kodak.

The word Kodak was first registered as a trademark in 1888. The first Kodak camera sold for $25 already loaded with film; and after 100 exposures, it was returned to the factory for the developing and printing of the pictures and the insertion of another roll of film. The cost of processing and of the new roll of film was $10. The camera made excellent pictures.

PK Again!

Dear Sir,

Thank you for publishing my first letter, together with the response from David Aldous. You did not publish my second letter on the subject, and you have perhaps wisely decided that this will be the end of correspondence on this matter in your letters column.

Mr Aldous's response is predictable, if perhaps over-stated. He makes clear his suspicion of serious science (my phrase, as he points out: he uses the curious phrase 'official science', which seems to have the overtones of Big Brother). It is often the case that proponents of the paranormal take such a view, often implying that scientists deliberately ignore evidence of paranormal phenomena. Some of your regular (and excellent) contributors will perhaps have been disturbed by this apparent antagonism towards science and scientists, which Mr Aldous seems to present as being your editorial policy.

There would seem to be a case for an article expressing the opposite point of view (ie a healthy scepticism towards paranormal phenomena), if only to ensure a balanced editorial viewpoint. I am sure I am not the only one of your readers disturbed by Maplin's new interest in psychic phenomena: an admittedly unscientific straw poll among my own friends and colleagues indicates that they would prefer to read electronics magazines which stuck to real science (to coin another phrase!)

Yours faithfully,
Graham Marett

The only reason we did not publish your second letter is purely to see what other response we would receive – sadly, to date, very little!

However, I feel we are missing the point here, as the inclusion of David Aldous' project, was for that very reason – it was a project – and one we felt, editorially, was different and very interesting. Whether, editorially or otherwise, we believe in the paranormal is not the issue, it was offered to our readers as a project for them to consider building. We try and offer a broad range of projects and ideas to cater for varying tastes, and to perhaps provide an alternative to the norm. We would, obviously, not expect all our readers to go out and build all our projects and kits, so all we can do is offer as wide a range of projects and ideas as possible. If we wanted to play safe then the magazine would contain nothing but audio projects, as these are the kits that Maplin sell the most, but I am sure that is not what our readership wants.

Finally, I note that you do not mention the inclusion of the monthly page from Uri Geller, which I would have expected to provide more comment. This page is intended to provide some scientific evidence of the paranormal for readers to come to their own conclusions. In passing, David Aldous demonstrated his project to Uri Geller with interesting results. I personally 'sit on the fence,' as I have never had a paranormal experience, but I have met people who have (as I am sure many of our readers have done), and they were convinced of the existence of 'something,' whatever we choose to call it. As scientists and engineers, it is dangerous for us to get 'stuck in our ways' – I am sure all of us need to remain open to fresh ideas and suggestions to evaluate and come to our own conclusions.

However, you are right when you say that an article expressing the opposite point of view is called for – there's a challenge? But remember, for it to be valid it would need to have some 'facts' and alternative scientific explanations (healthy scepticism) for it to be included.

Recycled CD-ROMs

Dear Sir

A lot of us have old PC computer bits lying around, like CD ROM drives and power supplies. Could these be made into an audio CD source for a Hi-Fi system? It would be ideal for upgrading my workshop Hi-Fi, where looks do not matter.

These CD drives have a line level audio out to connect to a Hi-Fi and the power supply is easy to arrange. All that is needed is digital signals for Play, Skip, Forward, Back etc. Can these be obtained by simple signals on the interface connector or is a complex digital word and clock needed? The project is probably not worth the effort if it is the latter. It would be a help if you could publish the interface specification for various drives.

The most common CD drives in junk piles are ones with Panasonic proprietary interfaces, followed by IDE interfaces. There are a few drives that have the Play, etc. buttons on the front panel, in which case it will play audio CDs without any connections to the digital interface.

I am not too sure how the audio quality of these drives matches up to the ones found in Hi-Fi equipment.

E. F. Chase

I am sure we have all thought about this as a possible use for redundant CD-ROMs. I would think that technical specifications for drives may well be available from manufacturers websites. Regards to sound quality, I would expect this to be very good, and we can certainly look into the practicalities of using these old drives. But you could argue that as we start to acquire old and redundant computers either as a result of buying new ones, or from old bits, that there is a possible application for these 'leftovers'- or would that be overkill?

Dear Sir

Thank you very much for the *free* novelty Christmas tree. My grandchildren age six and I will get much pleasure in its creation. I am a fairly new subscriber to your magazine and enjoy all its possibilities. You have asked us for our views and I know it is difficult to produce an *electronic magazine* for all the alternative enthusiasts' needs.

Electric cars are a wonderful subject for Electronics & Beyond to go really green over. I live on the Isle of Man and charge the batteries on my converted electric car by wind power – no power station involved. I use PWM (Pulse Width Modulation) to monitor and control a 3-phase motor with external circuits such as an opto-coupler interface to provide galvanic isolation and signal to noise immunity.

A Schmitt trigger is used to develop a clean output signal and a 15V positive logic drive is used to drive each motor phase via control circuits and high power IGBTs (Insulated Gate Bipolar Transistor). I could go on but this really needs some airing via your pages to allow the constructor to have a go after John Mosely's excellent explanation on options. Single seater electric karts or kit cars are an ideal way to start.

I need to take up Mike Bedfords point about electric cars. He must know that we can now choose our electricity supplier, and that some of these are 'green' companies and so need our support in the market place and should at least have a mention in his articles. Electric cars are currently driven with energy conservation in mind to achieve distance and economy. In the future, you still will be able to 'burn rubber' with hybrid EVs that more than match petrol engine vehicles – if that is your thing!

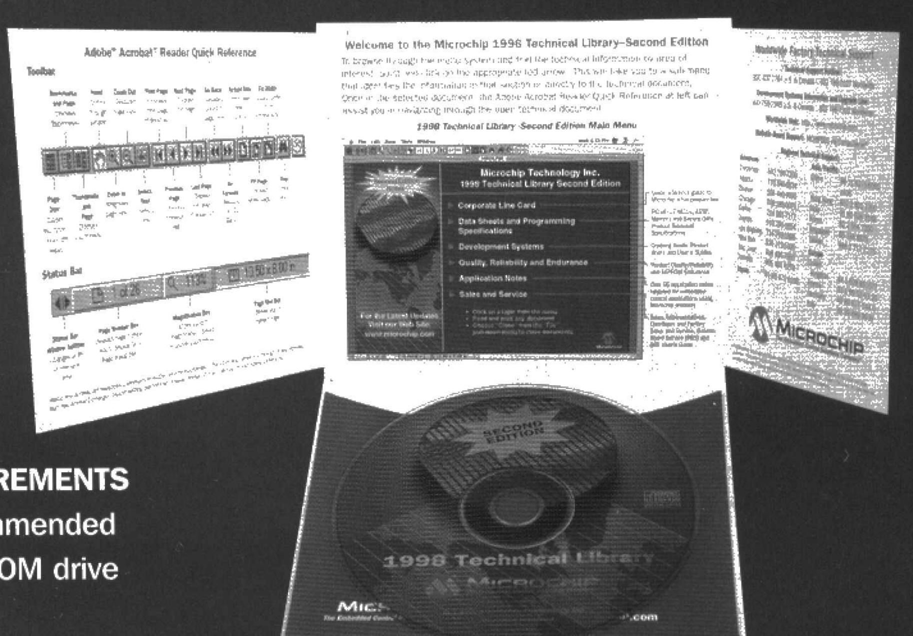
Tom Durrant
Isle of Man

We have been discussing electric cars in the office, and wonder if there is a market for second hand milk floats (serious!). Recently I visited Polperro in Cornwall where they were using at least two converted milk floats to each carry about eight passengers from the car park to the harbour. We have heard of one family that uses one to carry their children's musical instruments (double bass!) around. Also, I remember reading an article on how an enthusiast had converted an old Triumph Herald to run on car batteries and a couple of starter motors. By todays standards these are very 'basic' in their motor control, so if any readers have modern circuit ideas then perhaps they would like to send them in.

GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY

Maplin in conjunction with Microchip have 600 copies of the 1998 Microchip CD ROM to give away

This CDROM contains a snapshot of the Microchip Web Site (www.microchip.com). It will take you to a complete selection of documentation on the Microchip range of PIC 8-Bit MCUs, non volatile memory devices, ASSPs, KeeLoq code hopping devices and a full range of development tools.



MINIMUM SYSTEM REQUIREMENTS

- ◆ 386, Pentium PC recommended
- ◆ 16Mb Memory ◆ CD-ROM drive
- ◆ Hard Drive

Address your requests to: Microchip CD Giveaway Offer, Maplin ELectronics FREEPOST SMU94, PO Box 777, Rayleigh, Essex, SS6 8LU. ORDER AS OA06.

GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY • GIVE AWAY

Race Computer WITH SOUND AND 'FORMULA 1' START LIGHTS

Dr Mike Roberts shows how you can add sound, lights and precision timing to your slot car racing set.

Introduction

This project has revitalised interest in our old model racing car set. We needed of course several hours to test and prove the prototype!

My target was to design a unit which would be fun to use, easy to build and with better features than commercial equivalents. The inclusion of total time opens up the possibility of running competitions with more than two competitors, or on the other hand, hone ones own skills against the clock. The fastest lap is also recorded so you can see if it is always the fastest person who wins!

The full specification unit with backlit LCD display can be built for around £68 including the case but excluding the power supply (£7.50). A battery powered unit using a reflective display can be built for about £63. The starting lights are also emulated on the display so an even simpler unit without the LEDs can be constructed for about £59.

Circuit Diagram

Figure 1 is the full schematic diagram.

Car Detection

The cars are detected by light dependent transistors located at the bottom of the slots for the two cars. When a cars passes over the sensor the area in the slot gets very dark, even under good lighting conditions. By choosing a low level of light for the detection point a wide range of room lighting levels can be tolerated.

The detectors are in fact infra red detectors, but the type that does not exclude natural light. I found that their sensitivity to natural and incandescent light was greater than to IR light! Hence their use. I had also tried using simple light dependent resistors. These work, but the tolerance variation is wide and hence they take some trial and error to set up.

Under normal conditions (no car) the detectors TR1 and TR2 conduct holding TR3 and TR4 in their 'off' condition. When a car passes the detector stops conducting and TR3 or TR4 is turned 'on' by R16 or R18. This then triggers the 'eeeooom' sound (apologies for phonetic description), and triggers the PIC microcontroller at input X or Y.

Sound

Having found that the 'racing theme' sound chip in the

FEATURES

- Formula 1 style starting lights
- "eeeoom" sound as cars pass the start line
- Horn on last lap and finish
- 'Qualify' mode (times second lap)
- 'Race' mode – 5 to 250 laps
- Total time and fastest lap
- Battery or mains power

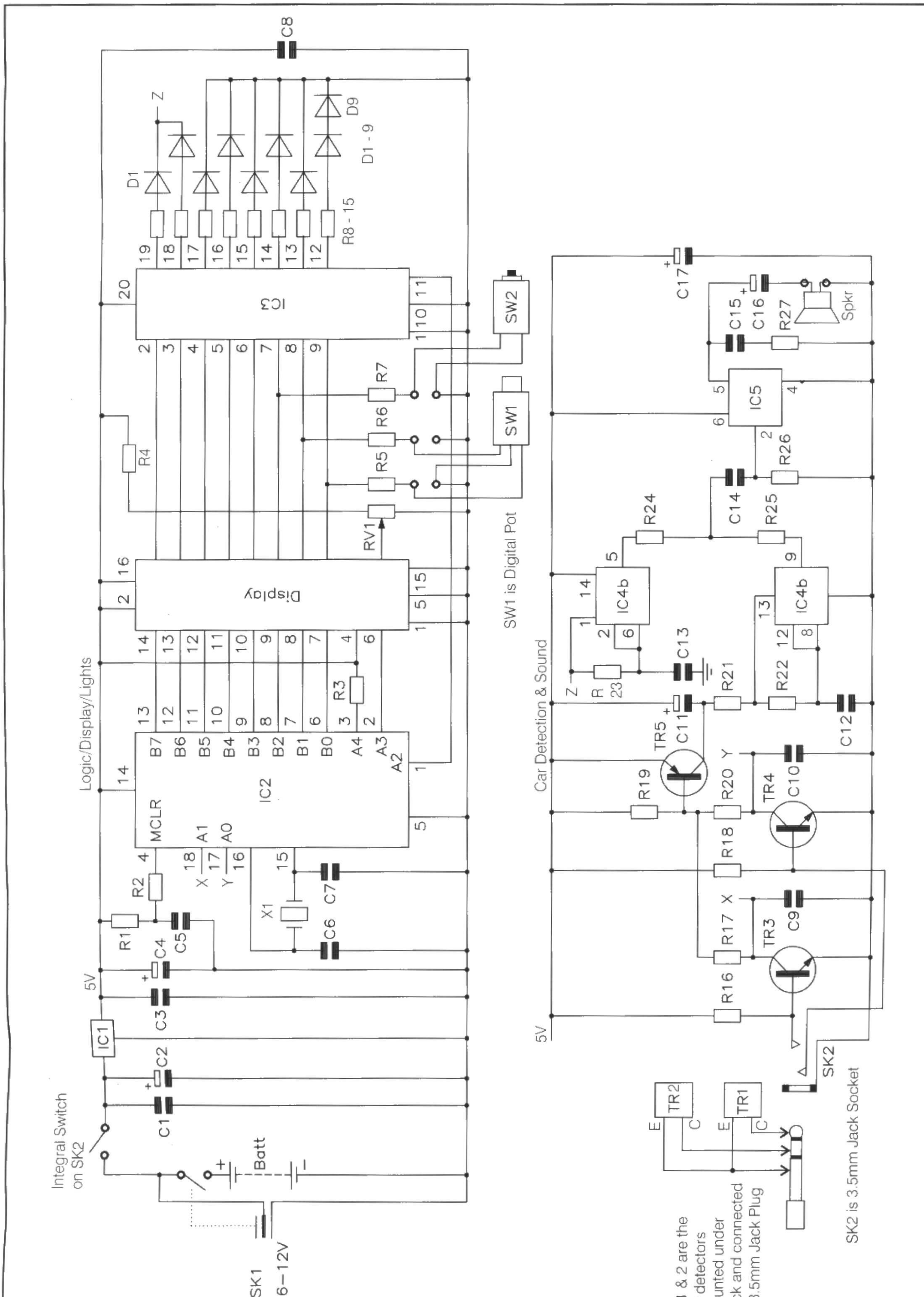


Figure 1. Main circuit diagram.

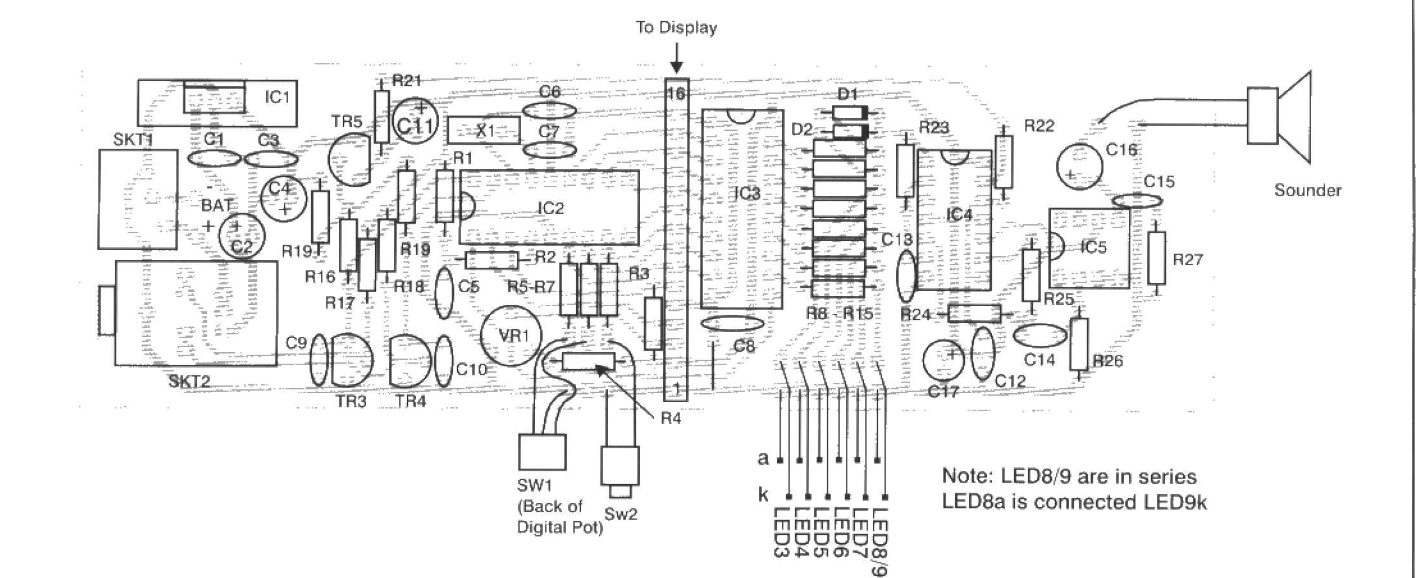


Figure 2a. Component overlay.

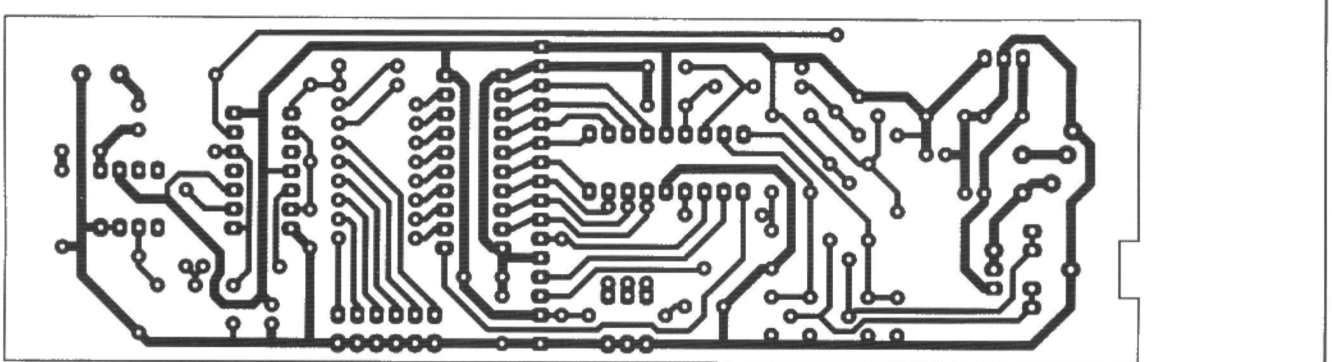


Figure 2b. PCB track layout.

catalogue made noises more like 'Space Invaders' I resorted to much simpler methods. The sound chip did at least cause some amusement when I demonstrated the noise it made in the Maplin Middlesbrough store!

The sound of a car passing is made by one half of IC4. While a car is over a detector TR5 is held in its conducting state and a fixed tone ('eeee') is generated. When the car has passed TR5 turns off and the voltage driving the R21, R22 chain falls as C11 discharges, giving a lower ('ooooooom') sound. This continues until the voltage driving R21, R22 becomes too low to trigger the timer at pin12.

The horn sounds for the last lap and end of the race for each track are generated by the other half of IC4. This is configured as a conventional astable. The drive comes via R8 or R9, giving different tones for each track. The resistors are pulled into place by IC3 which gets its instructions from the PIC microcontroller IC2. The combined outputs from the two halves of IC4 is then amplified by IC5.

Timing, Display, and Lights

These are all driven by the PIC microcontroller IC2. The cars detectors feed signals into PORTA bits 0,1. The other data into and from the microcontroller is handled by PORTB which acts an 8-bit data bus. This data is put to the display using the 'enable' and 'control/data' lines driven by PORTA bits 3,4. PORTA bit-4 is an open collector type and hence the need for the pull-up resistor R3. Data for the lights and sound is clocked into IC3 by PORTA bit 4.

The microcontroller also needs inputs for the 'start/stop' and 'up/down' buttons which set the number of laps. These are read into PORTB bits 0,1,2 via R5, R6, R7. This is achieved by switching PORTB to input when it is not sending data to the display or IC3 for the lights/sound. The prototype used a digital potentiometer to achieve the 'up/down' to change the number of laps. Separate 'up' and 'down' buttons can be connected. These are a pound or so cheaper but are nowhere nearly as easy to use.

Construction

Figure 2a,b shows the PCB track and component overlay.

Start with the one wire link and the resistors, then the IC socket for IC2, capacitors, then ICs, observing static precautions for IC3. Only fit IC2 into its socket when the board is complete.

Connect the display using 130mm of ribbon (or individual) cable. If using ribbon cable it is easier to make the connections in groups of four. Make sure that pin1 from the PCB goes to pin 1 on the display and so on. Connections 15,16 are only required for the backlit display. The Maplin 16 x 2 display has its own resistor to set the current for the backlight. A series resistor will probably be required if using a different display.

Connect the LEDs with 130mm cable. Make sure the cathodes go to the negative rail and note that the two green LEDs are in series. Similarly connect the input switch/ digital potentiometer with 130mm cable.

The PCB fits in the case in the slot below the slightly longer guides with the components towards the centre. The cutouts for the panel and side are shown in Figures 3,4.

The display mounts with 2.5mm screws. I set these flush with the front of the display and glue the heads in place with glue gun adhesive taking great care not to get any adhesive on the display panel. Use a 1/4in piece of wood inside the lip of the lid as a guide. If you do not quite get it right first time the position can be adjusted by applying a soldering iron to the back of the screw heads to remelt the glue.

The car detectors should be placed on the starting line, under the slots. Drill a 2mm hole if required to expose the raised lens on the detector. Fix in place with glue gun adhesive.

Operation

Power can be fed by internal batteries, a plug type power supply or from the car power supply (if it has the capability of providing an additional 300mA). DC power sources in the range 6-12V are suitable.

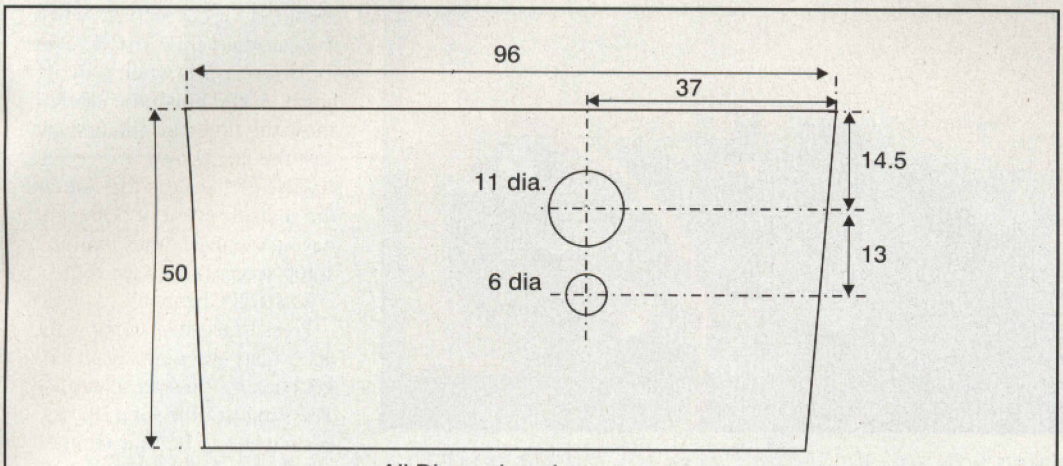


Figure 3. Side panel detail.

Track 1 is displayed on the left and track two is on the right. Each track operates independently. When a car passes the start line for the first time 'Qualify' changes to 'On trak'. Sorry about the spelling but this is the best I could do with 7 characters (to leave a space between the two halves).

At the start of lap two 'On trak' changes to 'Timing' and the clock starts. At the end of lap two 'Timing' changes to 'Time' and the clock stops showing the lap time. Pressing 'start/stop' at any time gets back to the start screen.

Power On

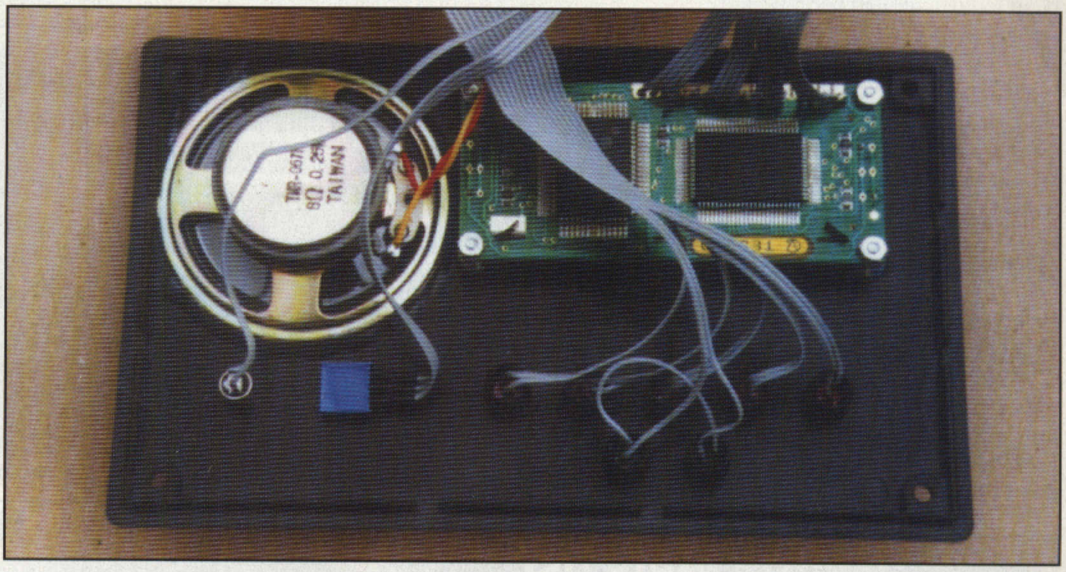
The unit is switched on by plugging in the detectors or turning on the power supply (when not using batteries). The display should show 'Qualify' on the first line and a graphic display of two cars ambling from left to right. I tried moving them faster but they became a blur.

Qualify

This enables the timing of one (the second) lap.

Press 'start/stop' to change the display to:

```
Qualify Qualify
0:00.00 0:00.00
```



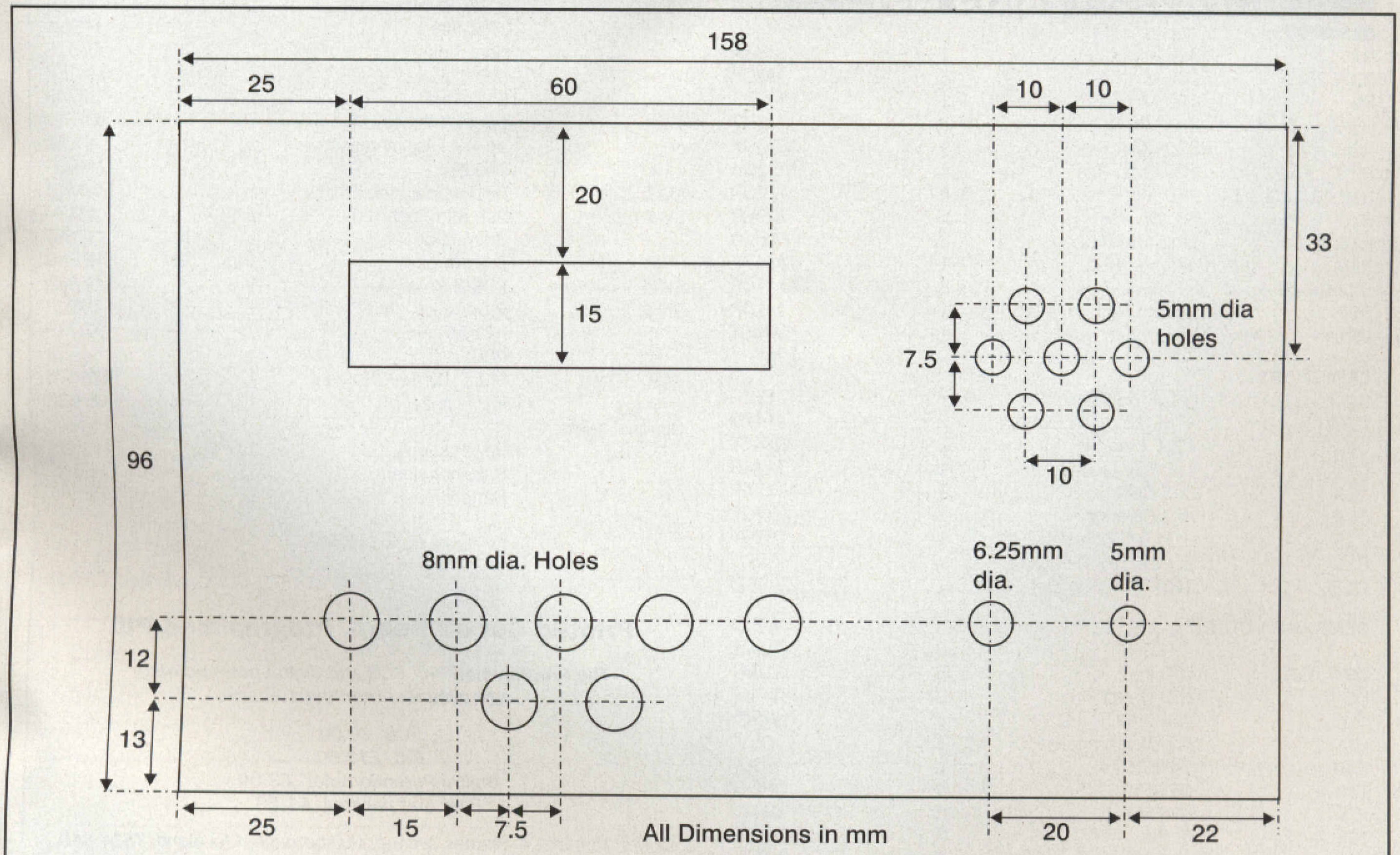
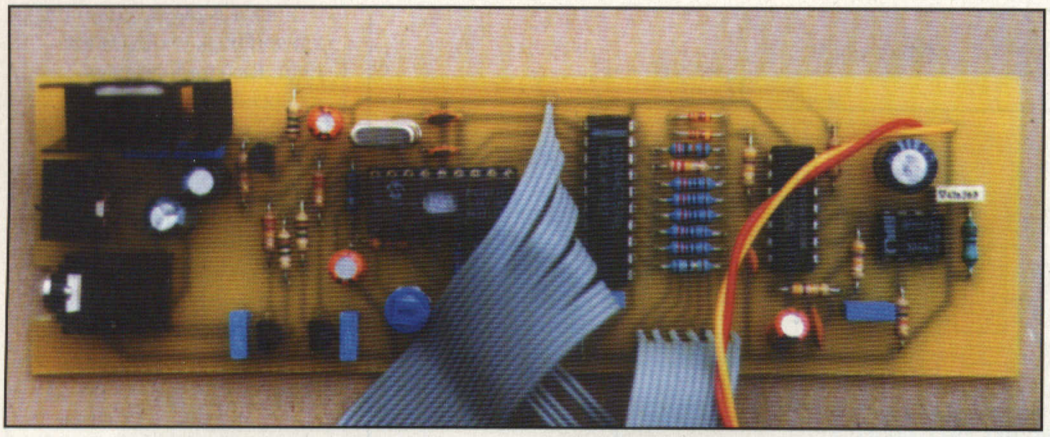


Figure 4. Front panel detail.



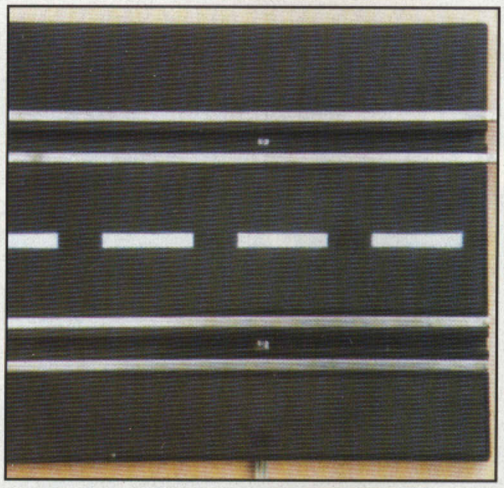
Race

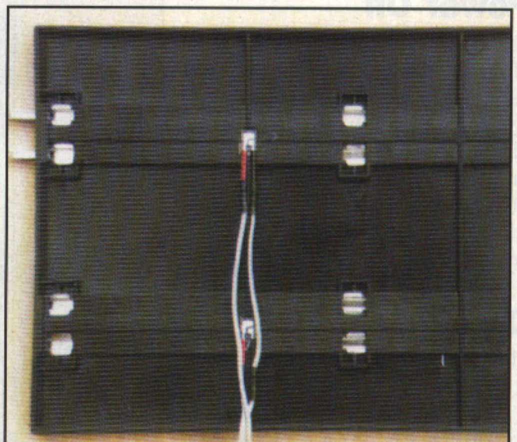
After the number of laps have been set the race can be started. Press up or turn the digital potentiometer to change to Race mode. The display shows 'Race n laps' where n is 5 to 250 in steps of five increased or decreased by up/down buttons or the digital potentiometer.

Press 'start/stop' to kick off the Formula 1 style start lights. First the green LEDs come on, then off with one, then two, then three, then four, then five red LEDs and finally all off and the race can start. The red LEDS are emulated on the display (but in monochrome!).

Clocks start on the bottom line of the display. When the cars cross the start line the top line shows 'Lap 0' for each track. This is incremented as the cars complete each lap. A horn is sounded for 0.2 seconds when the cars start their last lap and for two seconds when they finish. At the finish the clocks show the time and the first car past the line shows '*WINNER*' on the top line. In the unlikely event of both cars having identical times (within 1/100 second) both get the '*WINNER*' banner.

Press 'start/stop' to show the fastest lap times and again to get back to the start screen. The longest time for a lap has been taken to be four minutes which should be long enough. We typically achieve eight seconds on our track. ELECTRONICS





Placing photo transistors under track.

PROJECT PARTS LIST

RESISTORS			
R1	33k Min Res	1	M33K
R3,4,26	10k Min Res	3	M10K
R2	470 Min Res	1	M470R
R5,6,7	2k2 Min Res	3	M2K2
R8	330k Min Res	1	M330K
R9,17,20,22	220k Min Res	4	M220K
R10,11,12,13,14	220 Min Res	5	M220R
R15	68 Min Res	1	M68R
R16,18,21	1m0 Min Res	3	M1M0
R19	47k Min Res	1	M47K
R23,24,25	470k Min Res	3	M470K
R27	10 Min Res	1	M10R
VR1	1k Cermet	1	WR40T
CAPACITORS			
C1,3,5,8,9,10,14	0.1μF 63V Poly Film	7	DT98G
C2,4	47μF 25V Gen Elect	2	AT47B
C6,7	12pF Ceramic	2	WX45Y
C11	1μF 63V Gen Elect	1	AT74R
C12	3n3 Ceramic	1	WX74R
C13	2n2 Ceramic	1	WX72P
C15	0.047μF 63V Poly Film	1	DT97F
C16	220μF 10V Gen Elect	1	AT31J
C17	10μF 63V Gen Elect	1	AT77J
SEMICONDUCTORS			
D1,2	1N4148	2	QL80B
D3,4,5,6,7	LED Red	5	WL84F
D8,9	LED Green	2	CK40T
IC1	LM2940CT	1	AV22Y
IC2	Pre-programmed PIC	1	*
IC3	74HCT574	1	AE30H
IC4	NE556N	1	QH67X
IC5	LM386N-1	1	UJ37S
TR1,2	IR Rx	2	CH11M
TR3,4	BC549	2	QQ15R
TR5	BC559	1	QQ18U

MISCELLANEOUS			
X1	3.2768MHz crystal	1	FY86T
	IC socket	1	FJ66W
	Heat sink	1	FG52G
	LED clip	7	UK15R
	Enclosure	1	BZ74R
	16 x 2 Display LED	1	NT57M
or	16 x 2 Display reflective	1	NT56L
	Speaker	1	VC85G
SW1	Digital potentiometer	1	*
SW2	Sub Min Push red	1	JM47B
	3mm knob	1	JZ86T
	3.5mm plug	1	HF98G
SKT1	PCB 2.5mm pwr	1	FK06G
SKT2	3.5mm sw skt	1	JM22Y
	Ribbon cable	2	XR74R
	PCB	1	*
	M2.5 12mm CS bolts	1	BF40T
	M2.5 nuts	1	JD62S
Optional items:			
	Power supply	1	MG78K
	Battery holder	1	HF94C
	Battery lead	1	HF28F
*	Available from author.		

Printed Circuit Board, Programmed PIC

The Programmed PIC, PCB and digital potentiometer are available from the author:

PCB £6.00
PIC £12.50
Digital Potentiometer £3.00
Post and packing £1.50

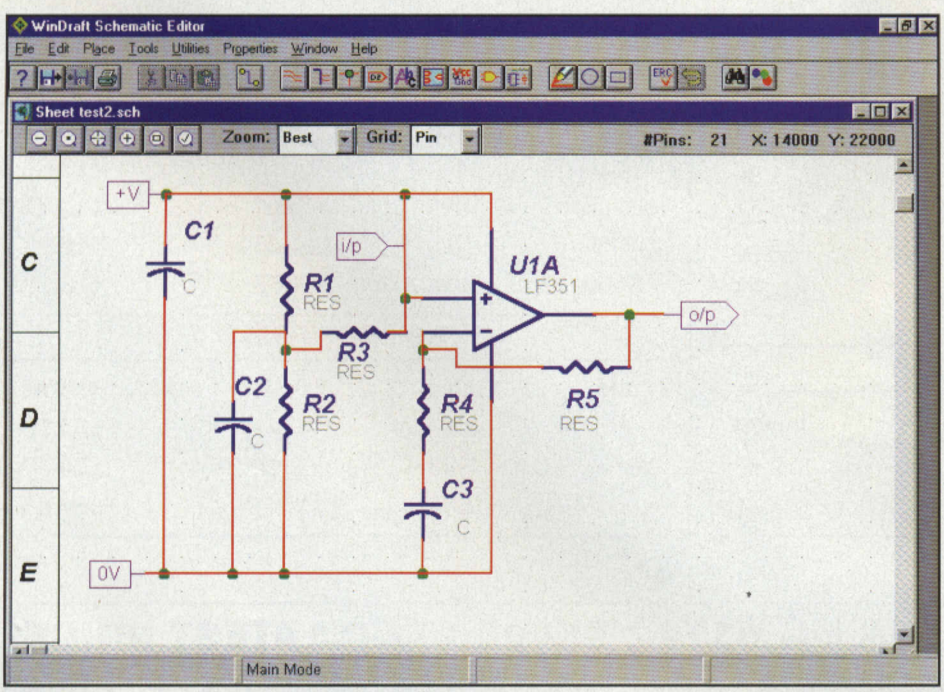
Dr M P Roberts, 4 Thames Avenue, Guisborough, Cleveland, TS14 8AD

WinDraft 2 & WINBOARD

Gavin Cheeseman evaluates these low-cost CAD PCB layout packages from Ivex Design.

The advent of affordable computer technology has considerably simplified the production of printed circuit boards. Computer Aided Design (CAD) systems for producing PCB layouts have been available for some time now but can often be relatively expensive for the occasional user or hobbyist. Low cost software is often limited in its application and may not be very user friendly. However, this is not always the case.

Maplin is introducing two low cost, high quality software packages for schematic and PCB design applications. WinDraft 2 and WinBoard from Ivex Design have many of the features of more expensive pieces of software but are available a very competitive price. The software is initially limited to designs of up to 200 pins but can be expanded. The package is ideal for home constructors wishing to produce their own circuit diagrams and PCB layouts. Comprehensive manuals are provided on the CD explaining how to use the programs.



WinDraft 2

WinDraft 2 enables circuit diagrams to be produced simply and efficiently. The software is supplied in CD ROM format and is Windows compatible. Comprehensive libraries are included covering a wide range of common circuit symbols. If the symbol you need is not in a library you can either create your own or modify existing symbols. Interconnections are easily made by clicking on the appropriate symbol pins. The setup option on the toolbar allows many of the operating parameters to be changed to suit different circumstances. For example different grid sizes and types may be selected. The software will automatically annotate the circuit diagram at the push of a button. Alternatively, the component designations may be entered manually. Once the circuit has been entered, the program will automatically produce a parts list. If you need to modify the circuit diagram at a later stage, this is not a problem as most parameters are easily edited.

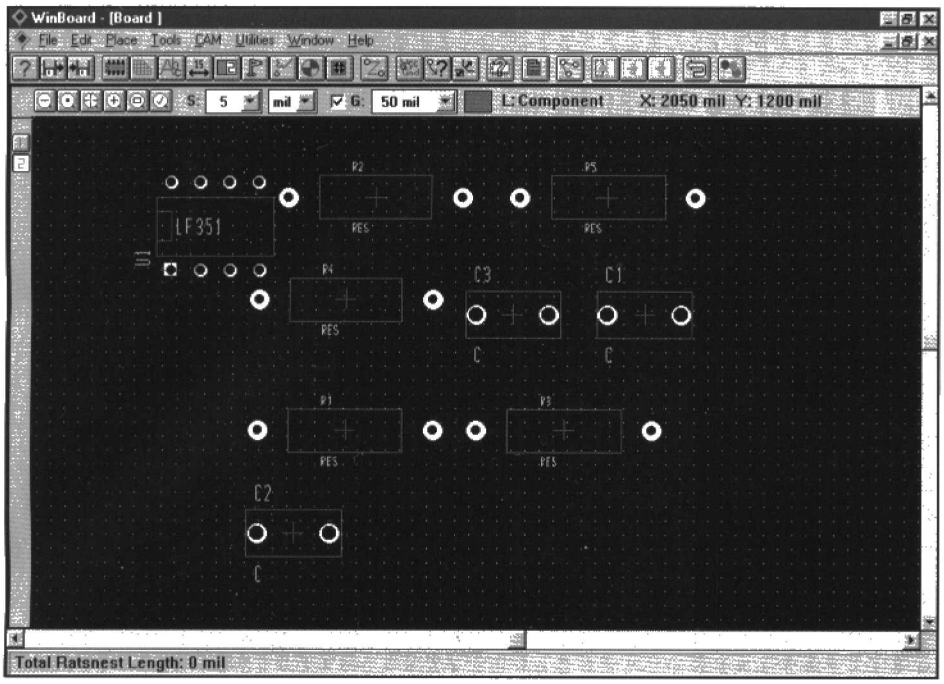
ERC (Electrical Rules Checking) allows the circuit diagram to be checked automatically to determine whether there are any fundamental connection errors. This facility will pick up errors such as unconnected terminal pins. The results of the error check can be displayed in the form of a report or shown as a marker at the appropriate point on the circuit diagram.

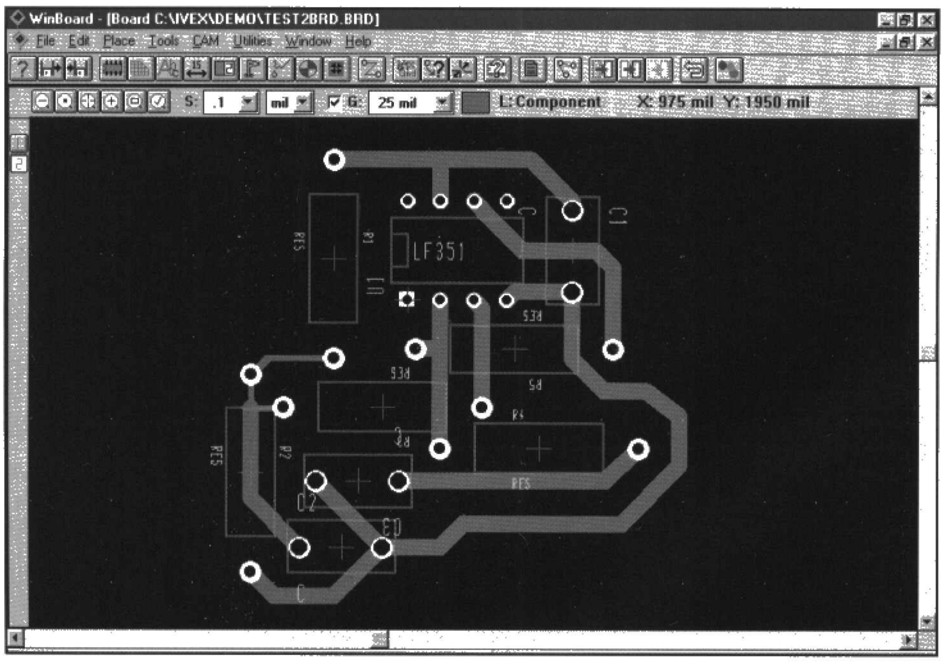
The program is compatible with WinBoard which can be used to create the actual PCB component and track layout. If necessary, the required track and component parameters relating to the PCB layout may be defined at an early stage in WinDraft 2. The program will automatically produce a net list from a circuit diagram which can be loaded into WinBoard and used to create a PCB layout.

WinBoard

Using the WinBoard program in its basic form, it is possible to produce board layouts with up to 200 pins, enough for most small board designs, and this can be expanded if required. Designs may be plotted or printed directly to the system printer. The software is designed for ease of use and designs may be produced rapidly with a minimum of fuss. If you become stuck at any stage, all you need to do is click on the help button to get a step by step guide.

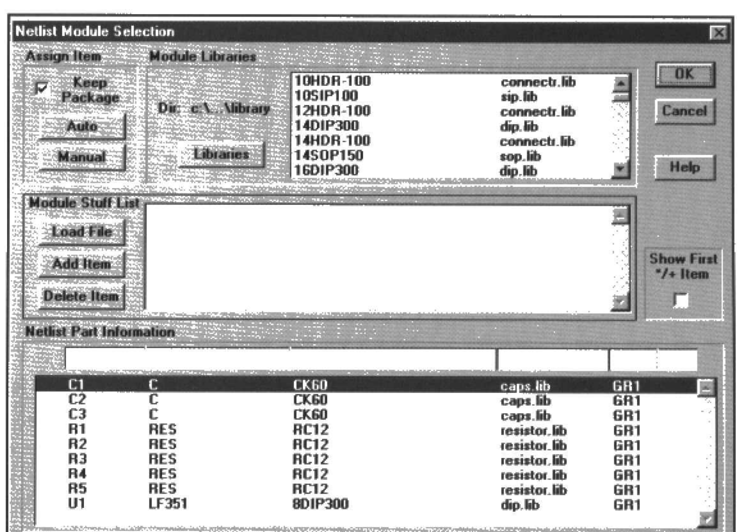
A net list produced in WinDraft 2 may be loaded into Win Board. It is also possible to





load some other net list formats. A copy of WinDraft 2 is included on the WinBoard CD. This copy is initially limited to a maximum of 100 pins. It is necessary to specify which component outlines relate to the components in the net list if this information is not already contained in the file.

There are extensive libraries covering a wide range of component outlines. Components may be selected from the libraries as required or alternatively can be created by the user. Once placed, the component modules can be moved by simply clicking on the outline and dragging it to the required position. Connections between components are displayed in a 'rats nest' format which appears when you click on a component pad. This aids efficient component positioning prior to routing the tracks. Once the components are suitably positioned, track routing can then take place. If you wish to move components at a later stage this is not a problem. Track connections are maintained when the components are moved. Acceptable angles for track corners are easily set by clicking on the appropriate menu button. Angles of 90° or 45° degrees may be selected. Alternatively, selecting 'any angle' allows the operator complete freedom to determine the angle when laying down the track. Arcs may also be defined.



The software allows extensive error checking (Design Rules Checking) to be carried out. It is also possible to compare the net lists at any stage in the development process highlighting any inconsistencies. Minimum clearances between PCB tracks may also be checked.

If required a PCB layout may be created directly in WinBoard without the need to create a circuit diagram. This is useful for simple designs if you wish to save time. The component outlines can be selected and placed in position manually. Tracks can then be routed as appropriate.

A complete PCB design solution

The software is ideal for hobbyists who wish to design their own PC boards and who have a suitable PC and laser printer. The circuit diagram can be quickly entered using WinDraft 2 and a PCB layout produced using WinBoard. The PCB layout can be printed onto transparent film and can be transferred to photo-sensitive copper clad board. Alternatively using the Press-n-Peel system (Maplin stock code AB15R), the design can be ironed directly onto standard copper clad board. The PCB is then etched and drilled ready for component insertion.

If after testing the design it is decided that modifications are needed, production of a second PCB is considerably simplified due to the editing facilities offered by the WinDraft 2 and WinBoard software. Of course, as long as you have saved your original design you can always return to it if the modifications are ineffective.

An Excellent Choice

Both WinDraft 2 and WinBoard provide excellent performance with many features usually only found on much more expensive packages. If you need to create quality PCB designs but don't want to break the bank then WinDraft 2 and WinBoard are well worth a look.

Both software Packages are available from Maplin.

Version	Order Codes	Price
WinDraft	PY01B	£24.95
Win Board	PY00A	£24.95

The Life and Times of LORD KELVIN

Douglas Clarkson looks at the life of this eminent scientist and engineer.

Introduction

To actually focus on the mainstream of thought of Lord Kelvin is to focus on the great resurgence of scientific thinking in the 19th century that would also underpin science and technology as one of the key determining factors of the 20th century. A study of the life and activities of Lord Kelvin is an account of the key roles he played in advancing scientific progress and becomes an in depth study of Great Britain at her zenith in the evolution of scientific thinking.

The Ulster Connection

William Thompson, as Lord Kelvin was known before his elevation to the peerage in 1892, was the son of James Thompson (1786-1849). So much of the social and religious outlook and intellectual aspirations can be traced back to James Thompson, and no account of William Thompson's career can omit this all important connection. The Thompson family had in fact in 1641 emigrated from Scotland essentially as farmers to the area of Ballynahinch – some 10 miles south of Belfast. The extended family, while establishing a firm platform in Northern Ireland, would continue to address the essential Scottishness of their traditions.

At the time of James Thompson's birth, Europe and America were passing through great transitions. The American War of Independence had ended in 1783 and in 1789 the fall of the Bastille in France confirmed the ascension of violent revolution.

Within Ireland, it was Liberal Presbyterianism in the north of the country that sought to establish an independent Ireland. The Battle of Ballynahinch in 1798 was to see the quelling of the rebellious Republican Presbyterian forces by British troops. This event would also trigger the ending of the Irish parliament in Dublin and the political management of Ireland from Westminster. All the rest, as it were is history.

James Thompson was the youngest son of John Thompson and so there was the perception that he would not inherit the family holding so he would have to make his own way in the world. James began his education in classes run by a certain Reverand Samuel Edgar in the session church at Ballynahinch aged around 14. By the age of 21 he was assisting in lessons and taking additional studies for entrance into Glasgow University, which he achieved in 1810 – returning during the summer break to assist with teaching.

The reason why James Thompson had to go to Glasgow for his college education was that Belfast, though a thriving commercial town did not have any suitable educational establishments. The Belfast Academical Institution was, however, opened in 1810 and James Thompson in turn took up a post there in the Mathematics and Arithmetic Department in January 1814 – becoming a professor of mathematics there in 1815. After a short engagement, James Thompson married Margaret Gardner in 1817. A series of seven children were born Elizabeth (1818), Anna (1820), James (1822), William (1824), John (1826), Margaret (1827) and Robert (1829).

The tragic loss of his wife in 1830, shortly after the birth of Robert forced some dramatic changes. A vacancy in the chair of mathematics at Glasgow University offered some light on a dark horizon. Eventually James Thompson took up his post in 1832 when William would have been around eight years old.

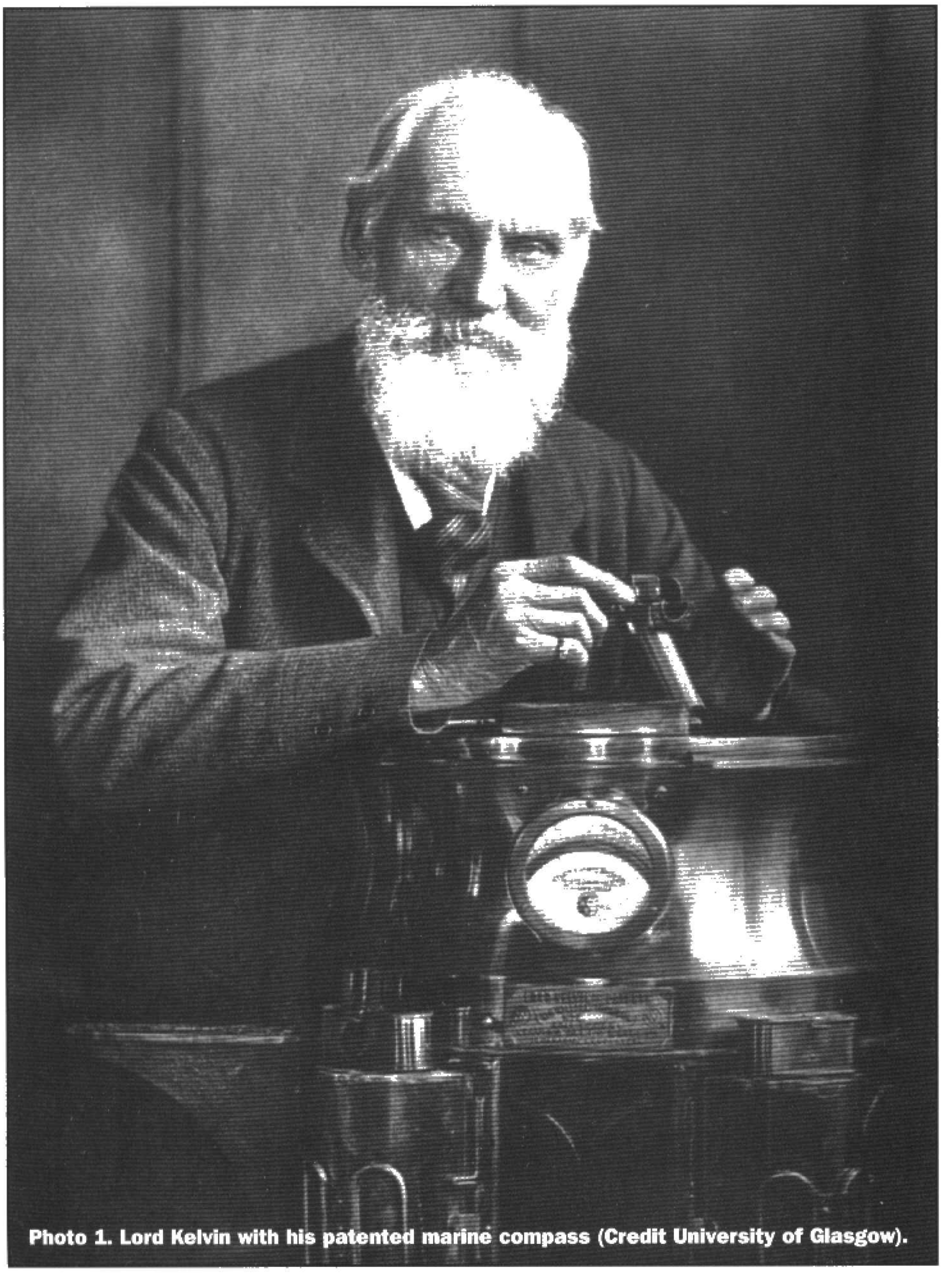


Photo 1. Lord Kelvin with his patented marine compass (Credit University of Glasgow).

On Scottish Soil

The next chapter in the story of William Thompson would be the actions of his father James Thompson to act as a reforming agent within the college, the education of William and the eventual success in securing for him the chair in Natural Philosophy at Glasgow University.

At this time, the establishment professors at Glasgow University, founded in 1451, did not reflect the rapid phases of change characteristic of the emerging Industrial Revolution. The development of mining, ship building, iron smelting, railways and the like were bringing forward whole new areas of commerce for expansion – the success of which increasingly would require the search for scientific and engineering knowledge and its application.

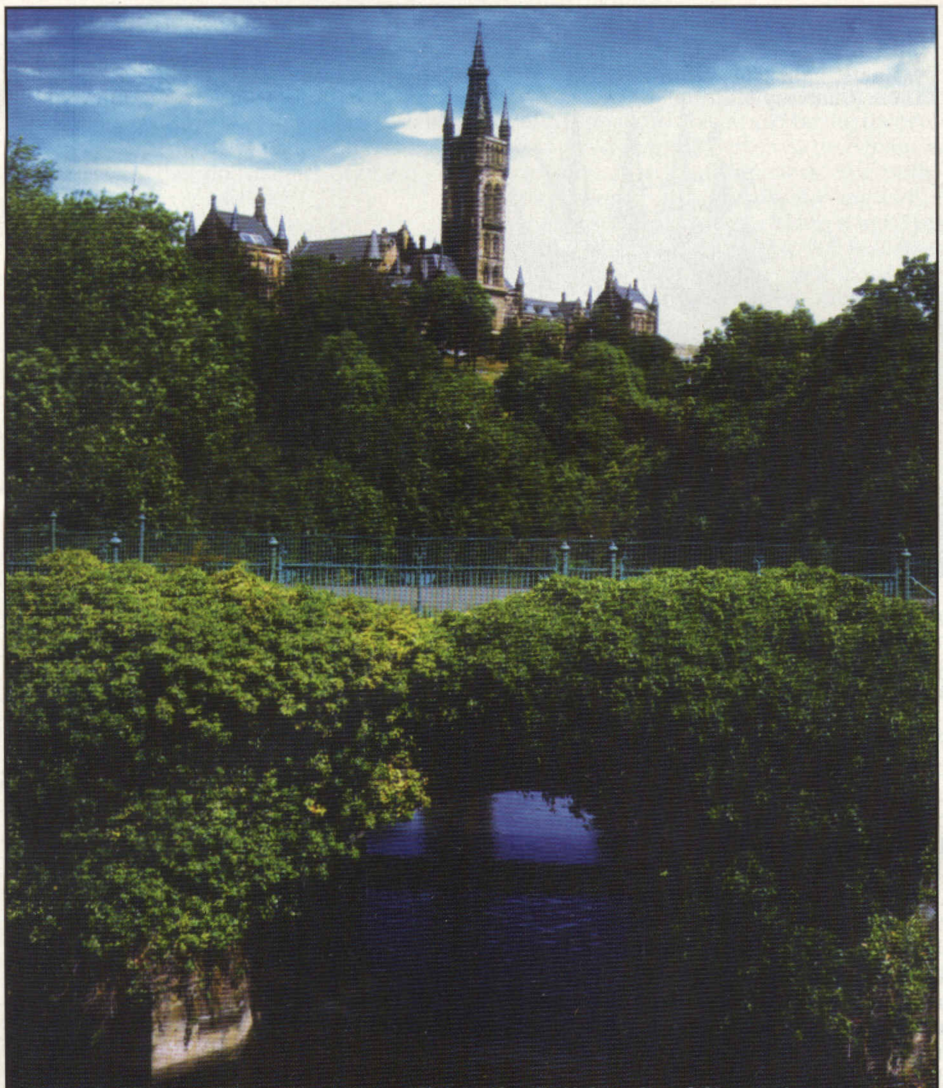


Photo 2. Glasgow University with river Kelvin (Credit University of Glasgow).

As Francis Bacon one commented in his essays ' no one prespereth as by the misfortunes of others'. The appointment of James Thompson as professor of mathematics at Glasgow University was in fact as a replacement for the disastrous endeavours of James Millar to carry out his duties. One noted event among many had been the ducking of the professor in the deepest past of the burn that ran by the college during an exercise in practical surveying. His lectures were marked with frequent disorder and student frivolities. Also, James Thompson discovered that due to a combination of circumstances, his income was much less than expected.

James overcame this problem by setting up additional lectures in geography and astronomy for young ladies. Under his more professional approach, his works proved an outstanding success, his class sizes increased and his publishing ventures bore considerable fruit.

The early education of James Thompson's sons was unorthodox, probably in part due to the initial lack of funds to send them directly into schooling. They received much of their early education at home. Once they had been installed with the wonders of knowledge, the process of learning became almost self regulating and self motivating and with an older child teaching a younger one.

William and his brother John matriculated at Glasgow University in 1834 when William was only ten years old. William was due to enter Cambridge some years later in 1841, and during this time we see a family focused in the pursuit of learning and mixing with a broad range of stimulating intellects in a wide professional and social circle. The means whereby all of this could be afforded came from the labours and efforts of James Thompson who proceeded to also expand the minds of his entourage by taking them on tours of the continent in 1839 and 1840. His older brother James was to achieve an MA in mathematics and Natural Philosophy in 1839-40, but William himself chose not to take a degree at Glasgow. The eventual move of James to the profession of engineering was to be highly significant for William since it would be James that would present William with all of the deep questions about the efficiency of heat engines at a time when there was no formulation of the laws of thermodynamics. These questions, however, were very much at the core of the phase of rapid industrialisation that was taking place through the harnessing of steam power. Economic success was ruthlessly achieved by securing mechanical efficiency, but possession of scientific and technical knowledge was no guarantee of commercial success. There was a perception as a result of noted financial failures among engineering works in England, through a lack of 'efficiency' in implementing solutions, that machine economy was better practised and implemented in Scotland.

Onwards to Cambridge

It was evident that the particular talent of William with regard to mathematics could not be furthered at Glasgow or Edinburgh. It was at Cambridge where especially the new French mathematical physics was handled at a particularly thorough level and would accordingly benefit William in any future career within science.

James Thompson was especially astute in entering William in St. Peter's College (Peterhouse) where William Hopkins would act as William's private tutor in mathematics. This was in fact the critical interface for learning – formal lectures tended only to set the tone of learning and not address the content of study.

The expense of maintaining William at Cambridge was by no means trivial. The cost of maintenance alone per year was of the order of £230.00 – a not inconsiderable sum. In terms of divisions of enthusiasm between students, there were the independently minded individuals such as William Thompson and the 'rowing men' – who would put most of their best endeavours in messing about in boats on the river Cam. Has anything changed?

It was almost too much for his father to learn that one day William had bought a share in a boat for £7.00, which turned out to be a good investment. William was to comment, "and I find that I can read with much greater vigour than I could when I had no exercise but walking, in the inexpressibly dull country around Cambridge."

In the all important Senate House examination which began on 1st January 1845 and ended on the 7th after twelve papers, William was in fact to take second place behind Stephen Parkinson of St. John's college who became for that year 'senior wrangler'. It was the opinion of William Hopkins, that William had by far the better mathematical mind by way of his ability to see new perspectives in emerging mathematical landscapes. William, however, came first in the Smith prize examination held towards the end of January. There was the impression, that the elite educational system of Cambridge was geared to 'drilling' students to pass examinations rather than making them reflect in an expansive way about the world about them.

James Thompson was mindful not only to direct and manage his own career but also to find where possible the means of advancement for James and William. It was the right of professors, not so much to retire from office at a specified age but to continue in office until physical health failed completely. The frailty of professor Meikelheim of Natural Philosophy around the time William was at Cambridge, was forcing a process of searching for a likely successor. James Thompson discretely surveyed the scene, but was in fact directed by professor of Astronomy – professor J. P. Nichol to consider William for the post.

Once James Thompson perceived that there was indeed an opportunity for William to gain the post, he engaged on a process of securing a large number of testimonials relating to the ability of his son from a wide range of influential individuals within the prevailing University system. It had been recognised that William had a lack of experience of experimental technique and so he was accordingly bundled off to the Paris laboratory of Victor Regnault. When professor Meikelheim departed this life on May 6th 1846, the successful campaign of

James Thompson saw his son William installed as professor of Natural Philosophy at Glasgow University at the age of only 22 on the 11th of September 1846. The process of appointment was one of voting by the existing 15 professors of the college. More perhaps as an assessment of the ability of William rather than the campaign of his father, the vote was unanimous.

A Man of Experiments

Professor William Thompson was active in changing the base function of science in society – transforming it from a means of understanding of the universe better to a mechanism for industrial growth and wealth creation.

As he aptly commended, "Scientific wealth tends to accumulate according to the law of compound interest"- meaning that the correct application of science can lead to the development of increasing levels of material wealth. This approach probably followed from the example of his father who had made a respectful income from a range of academic endeavours. Professor William Thompson provided a new perspective in the learning process – "The object of a university is teaching, not testing... the object of the examination is to promote the teaching." How true is this of education today?

As regards his teaching style, parts of his lectures were more points of discussion than a setting down of laws and values. Points of current research, such as the change of freezing point of water with pressure would be commented on, as if his own ideas of new discoveries were shared for comment with his classes. There was also, a great deal to discover.

William Thompson was to discover that he was woefully short of human resources since experimental work was very time consuming. He had the insight to invite students to help him in his experimental labours. This represented a major transformation of the traditional learning process where students were formerly quoted experimental findings or were demonstrated the results from a distance. From his 100 strong junior class, around 25 found time to devote several hours per day to such experimental work. These students thus gained the benefit of experimental work and with William Thompson managing to have useful work undertaken. There was also the element of importing ideas of more active laboratory work from the continent.

A key aspect of William Thompson's practical work would be the development and refinement of a wide range of measurement equipment. One of his useful devices was the attractive disk electrometer as shown in Figure 1. By careful control of physical parameters of the instrument, the unit could be used as an 'absolute electrometer'. A sophisticated device was later designed by William Thompson in 1888 to undertake measurements in the region of 200V to 5000V. William Thompson was keen

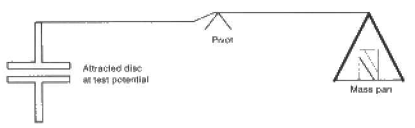


Figure 1. Principle of attracted disc electrometer developed by Kelvin.

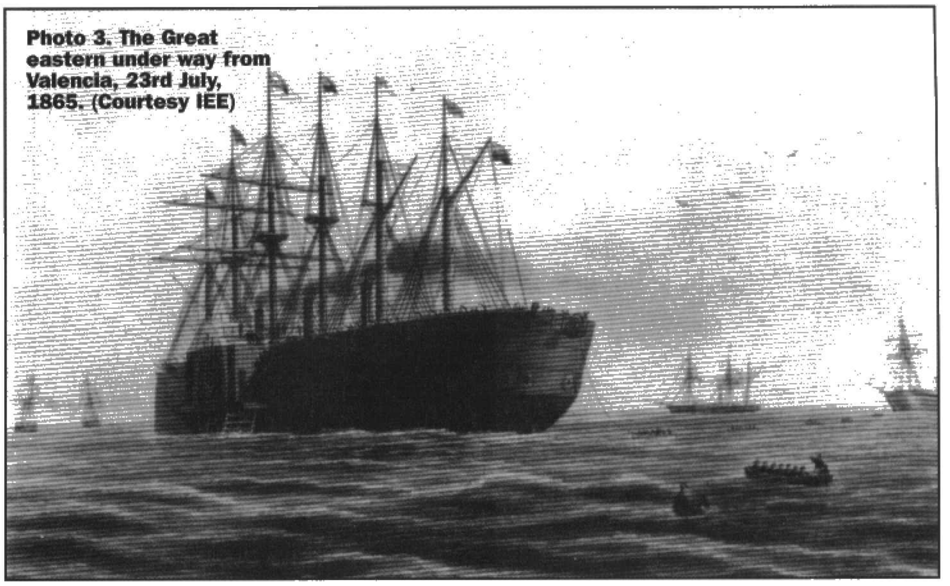


Photo 3. The Great eastern under way from Valencia, 23rd July, 1865. (Courtesy IEE)

to establish an appropriately resourced measurement laboratory and in the first five years of his appointment, the Faculty advanced £550 for new apparatus.

At this time the discipline of Natural Philosophy was a component of the broad philosophical curriculum at Glasgow University which normally proceeded professional training in theology. William Thompson was slowly but surely changing the very nature of Natural Philosophy at Glasgow – and directing it into a mainstream subject in its own right, rather than a branch of a rather aged tree. William Thompson possessed, however, the deep insight that the humblest person, crofter or artisan, was capable of understanding the nature of the physical world as revealed through the art of experimentation.

With the building of an imposing new university campus within Glasgow at Gilmorehill, a new Natural Philosophy building completed with a much improved series of laboratories, was opened in 1870.

Fever City

Glasgow was by no means immune to the unwelcome visitation of disease. During the 1830's and 1840's there were numerous outbreaks of typhus and cholera. William's younger brother John, in training as a doctor at the Infirmary, fell a victim to fever in February 1847. Worse was to follow when his father died from Cholera in January 1849. William's younger brother Robert, a sufferer of poor health in his early years, emigrated to Australia around 1850. In a period of adverse family fortunes, William was of a mind to seek out marriage. After his first love Sabina Smith turned him down no less than three times (but she would have said yes when asked for the fourth time), he married the accomplished Margaret Crum in September 1852. Unfortunately Margaret became seriously ill after an exhausting tour of the Mediterranean in May of 1853 and never really recovered a tolerable degree of health. Sadly she died at Largs in June of 1870.

On a slightly happier note, William Thompson would later meet his second wife – Frances Anna Blandys – on the island of Madiera while investigating a fault in a telegraph cable in the hold of the ship Hooper. They would be later married on the 24 th June, 1874 – on William Thompson's fiftieth birthday.

A Man of Theory

The choice by William Thompson to study mathematics at the most rigorous level possible in Britain was indeed well placed. The unfolding era of science was to be one of experimental measurement coupled by the evolution of the language of mathematical physics as the 'dot' notation of Newton was to give way to the 'd' notation of Liebnizian differentials. The development and clarification of mathematics would in fact be necessary to model and explain whole new areas of experimental science.

In particular William Thompson had been profoundly influenced by the mathematical work of Joseph Fourier as presented in the analytical theory of heat published in Paris in 1822. William Thompson was to seek to derive solutions to many problems using the Fourier approach.

This was also the time of the reforming nature of British Science with the foundation of the British Association for Advancement of Science in 1831 with its association with famous names such as John Herschel and Charles Babbage.

It was Thompson, at about the time of succeeding to the chair at Glasgow, who crystallised out an understanding of potential (voltage), the electric field and the work done in moving of charges within electric fields. This had been developed from observations of Gauss in 1843. This work was also undertaken at a time when the intrinsic nature of electricity had not been determined. One of the great difficulties of science around this time, and for electricity and magnetism in particular, was the lack of a uniform set of terms for even the same phenomena. Units of measurement was also a problem – there were none. While luminaries like Faraday had made unique discoveries around 1840, the language of reporting of these would tend to be highly personalised and with Thompson initially refusing to take Faraday's work seriously on account of Faraday's inability to express his empirical findings within a sound mathematical framework.

The Absolute Scale of Temperature

His brother James, with his constant preoccupation of rendering machines as efficient as possible for their sources of fuel, would constantly turn William's mind to

resolving such questions. James, on the other hand, was but little interested in the much broader universe of his brother. It was indeed a paradox for the industrial revolution to be gathering pace but with no better intrinsic understanding of the nature of the laws of thermodynamics or of the very reality of heat itself.

It was during this phase of coming to grips with the Laws of Thermodynamics that William Thompson first related his concept of an absolute scale of temperature. Writing in 1847 he relates that "A good deal has been said in various treatises about fixing an absolute standard of temperature. The air thermometer is chosen merely for (convenience) of comparison. Now would it not be a good absolute definition of equal degrees to say that they are such that the same quantity (determined in an absolute way by the melting of ice) descending a degree will always produce the same mechanical effect?"

Here William Thompson is essentially introducing the definition of an agreed temperature scale where a change of temperature in a body can be defined against a specific amount of mechanical work. He would determine in the cycle of operation of a heat engine that removing heat Q1 from a reservoir at state temperature T1 and returning heat Q2 to the cold reservoir at state temperature T2 would constitute the relation:-

$$(T1/T2) = (Q1/Q2)$$

where T1, T2 are the absolute temperature states of the reservoirs.

He would further show that this absolute temperature based on thermodynamic considerations would relate directly to the temperature relation identified in the ideal gas laws – Charles and Gay-Lussac.

Encounters with Joule

James Prescott Joule in his researches into the equivalence of work and heat was very much a voice in a largely disinterested scientific wilderness. His theory of heat being the energy equivalent of work did not match prevailing theories of heat such as that propounded by Carnot. It was the encounter of William Thompson at the British Association meeting of 1847 in Oxford that would both rescue Joule from obscurity and provide Thompson with the insight to see that the existing theories of heat and work were intrinsically flawed.

It was this support of William Thompson that led to Joule's famous paper presented to the Royal Society in 1850 on the mechanical equivalence of heat. The full understanding of the transference of heat at one temperature to another with the undertaking of mechanical work would require further years of theory refinement. The fruits of this debate would be William Thompson's famous series of papers 'on the dynamical theory of heat' published between 1851 and 1855.

His first preposition was essentially to agree with Joule on the equivalence of mechanical energy and heat – "When equal quantities of mechanical effect are produced by any means whatever from purely thermal sources, or lost in purely thermal effects, equal quantities of heat are put out of existence or are generated."

His second proposition was better expressed in a footnote – "it is impossible, by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."

Thompson was to become aware of the law of increasing entropy as systems are driven towards intrinsic irreversibility of heat dissipation. This would be the theory that would alter the perceived time frame of the Universe to Victorian minds. The earth was cooling and the sun was cooling and these processes could not be reversed. This altered scheme of things was well expressed as – "I believe this tendency in the material world is for motion to become diffused, and that as a whole the reverse of concentration is gradually going on – I believe that no physical action can ever restore the heat emitted from the sun, and that this source is not inexhaustible; also that the motions of the earth & other planets are losing vis viva which in converted into heat ..."

There was given the image of a large watch, having one been wound up – slowly winding down.

Cosmic Controversies

The science of the 19th century would be responsible to a great extend for influencing thinking in terms of man's place in the Universe. The advances of William Thompson's theory of the universal dissipation of energy – of how things like the sun could only get colder – began to produce figures for the age of the sun and the remaining years of its activity. Arguments would also centre round the age of the earth as derived from estimates of its process of cooling through the ages.

This was one of the first instances of the pronouncements of science interacting with the public at large. Various theories were contemplated of the means whereby the sun could radiate such vast amounts of energy – which could now be estimated through the developed skill of scientific observation.

The essential questioning mind of William Thompson can be discerned in his comments – "The energy, that of light and radiant heat, thus emitted (by the sun), is dissipated always more and more widely through endless space, and never has been, properly never can be, restored to the sun, without acts such as much beyond the scope of human intelligence as a creation or annihilation of energy, or of matter itself, would be. Hence the question arises, What is the source of mechanical energy, drawn upon by the Sun, in emitting heat, to be dissipated through space?"

What we see is the contemplation of science able to work out numeric values associated with distant events. The energy output of the sun was estimated to be the equivalent of 7000 horse power per square foot. One theory of the sun's heat accounted for this phenomenon by meteors falling into the sun for which 2000 pounds per square foot would be required annually.

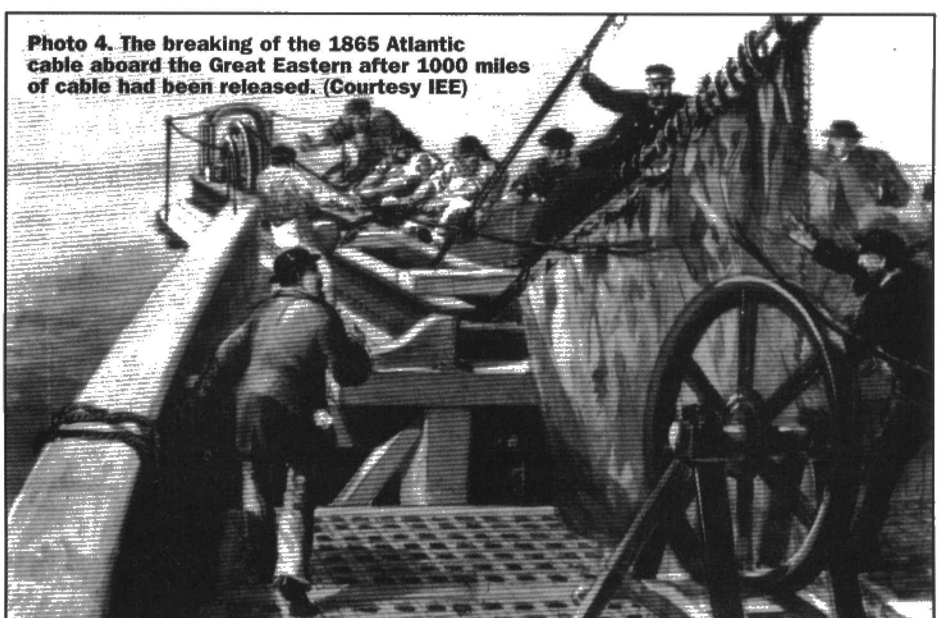
There is also here the perception of the ability of science in the role of William Thompson and his associates, to be able to obtain answers to complex physical questions and in turn building a view of man's role in the more expansive universe.

Latterly Thompson was to favour the theory of gravitational contraction of the sun, and to narrow the time of its existence between 100 to 500 million years. This in turn provided at the time one time scale with which life could have evolved on earth. William Thomson while reviewing with cold logic problems engaged in abundant theory and mathematical calculation, could at the same time appreciate the greater vision of the reality of the much larger physical universe. As Thompson noted, "I often feel thankful to have lived in the reign of Queen Victoria, but I have not been sufficiently thankful for the average distance of the earth from the sun being so exactly what it is. Surely there is no other place in the universe with life!"

The question of the age of the earth would also be considered by processes of mathematical modelling. Towards the end of his life, new sources of energy such as radioactivity discovered by Henri Becquerel in 1896 would provide scope for revising upwards the age of the earth as determined solely for a model of a cooling body. It would be, however, the younger set of physicists that would pick up these trails – with William Thompson that there was not any serious probability "of radioactivity having a part in the age of the earth." The best estimates that William Thompson could effect for the age of the earth based on simple cooling theories was between 20 and 400 million years.

William Thompson was also interested in the tides of the earth, since this would produce a retardation of the earth's rotation

Photo 4. The breaking of the 1865 Atlantic cable aboard the Great Eastern after 1000 miles of cable had been released. (Courtesy IEE)



that would have significance for theories of the age of the earth. From the best of his endeavours, he calculated that this should produce a loss of angular velocity corresponding to 3.6 seconds a year.

The age of the earth debate would set increasingly the physicist against the geologist, as the following encounter indicates at the end of a lecture by a geology professor on the processes that had shaped Scotland's scenery. In conversation are William Thompson and Sir Andrew Ramsay in 1867

"You don't suppose things have been going on always as they are now? You don't suppose geological history has run through 1000 million years?"

"Certainly I do."

"10,000 million years"

"Yes"

"The sun is a finite body. You can tell how many tons it is. Do you think it has been shining on for a million million years?'

"I am incapable of estimating and understanding the reasons which you physicists have for limiting geological time as you are incapable of understanding the geological reasons for our unlimited estimates."

"You can understand physicists' reasoning perfectly if you give your mind to it."

The debate over the age of the earth was very much a focus of scientific conflict as the theories of science grappled with the evidence of the geological features of the earth. At the same time, however, the industrial revolution was gathering momentum.

Enter Market Forces

The greatest driving force of 19th century science had also been the implementation of the labour theory of value – where very much in the spirit of Adam Smith, where the processes were to be determined in the cheapest way of producing a satisfactory outcome. This would drive towards the most efficient machinery being operated at the lowest cost.

We possess the same set of values at the end of the 20th century as were introduced during the largest phase of industrialisation and with a major contribution to its implementation by William Thompson and his brother James the engineer. However, William was mindful to look to the future in an account given in 1881 to the British Association on 'the sources of energy in nature available to man for the production of mechanical effect'

"The subterranean coal-stores of the world are becoming exhausted surely, and the price of coal is upward bound – upward bound on the whole, though no doubt it will have its ups and downs in the future as it has had in the past, and as must be the case in respect to every marketable commodity .. (Therefore) it is most probable windmills or wind-motors in some form will again be in the ascendant."

Well done Lord Kelvin – we agree with you.

Telegraphing the World

While the Victorian Age is attributed to the ascendancy of the British Empire, it also marked the beginning of the telegraph with the work of Cooke and Wheatstone in 1837. The first great international exhibit at Crystal Palace in 1851 coincided with the first successful submarine cable between England and France.

William Thompson became involved in telegraph cable technology after reading an account of work undertaken by Faraday in 1854 at the behest of the Electric Telegraph company. It was Thompson who applied the mathematical method of Fourier to a model of conduction in the cable and which predicted that the delay in propagation in pulses was proportional to the square of the length of the cable. Thus a cable four times longer would have a delay some 16 times greater for a similar construction. Thompson was soon to appreciate the significant commercial value of these deliberations. The laying of the first Atlantic cable took place in July 1857. William Thompson had by now made his theories regarding propagation delays well known and the design of this first Atlantic cable essentially conforming to these ideas. Yet in a certain Wildman Whitehouse, engineer of the Atlantic Telegraph company, there existed an individual who had acquired knowledge of telegraphy without scientific training. After some false starts and various mishaps, the cable was completed in August 1857 with William Thompson being present on the British ship HMS Agamemnon – and surviving a near ship wreck into the bargain.

Messages were exchanged between Queen Victoria and President Buchanan of the USA. The first Atlantic cable, was very much a British development than one initiated by the USA. In its short life it transmitted a total of 732 messages – finally failing in October 1858. This was, however, typical of many lengths of cable laid at around this time. The failure of the cable was probably a combination of circumstances – flaws in manufacturing, damage in storage and transit and the use of inappropriate cable laying equipment had probably placed the cable under undue stress. Also, Whitehouse had tried to literally 'spark' the cable into life using 2000V induction coils that could cause a spark to jump two inches in air. Also, for most of its operating life, messages could only be transmitted by means of William Thompson's patented highly sensitive mirror galvanometer. The failure of the first atlantic cable was no trivial matter. A committee of the Board of Trade thoroughly investigated the entire venture – interviewing among many both Whitehouse and Thompson in the process. This would consolidate Thompson's position as the scientific point of reference for future ventures and thoroughly discredit Whitehouse.

With an improved approach to manufacturing and cable laying, the Great Eastern ship of Brunel and Russell of 20000 tons set to lay a new cable in 1865 with William Thompson on Board. Almost at the half way point the cable snapped and could not be recovered, but in the following year came success. A new cable was laid and the 1865 cable picked up and recovered. For his endeavours in advancing the cable technology, William Thompson was awarded a knighthood in 1866.

One of the more significant commercial developments for William Thompson was his so called siphon recorder which used the deflection of an ink jet to automatically record switching patterns in telegraph cable traffic.

Towards International Standards

Much of the formal structuring of standards of formal measurement had been devised within the workings of the British Association for the Advancement of Science. A key aspect of this work would be the relation of units around the definition of units of work and also the development of systems for accurate measurement of such quantities. In this specific process William Thompson would play a key role.

In the process of determining standards, there was four key equations:-

1.	I	$= E/R$ –	Ohm's Law
2.	Q	$= I\,t$ –	Faraday's Relation
3.	W	$= I^2R\,t$ –	Joule's Law
4.	F	$= Q/d^2$ –	Coulomb's Law

Equation 1, 2 and 4 represented the 'electrostatic' system favoured by Weber but without the concept of equation 3. There was a priority, however, for the use of standards that related to electromagnetic effects – such as the force on a current carrying wire in a magnetic field. The so called 'BA Ohm' was to be derived from this form of measurement and was subsequently adopted at the first International Congress in electrical standards held in Paris in 1881 and with William Thompson and Helmholz acing as co-chairmen.

Around 140 years later, however, we seem to have lost the edge on the superb experimental skills of these intrepid Victorians. For example, in the experiment to rotate coils around a magnet it is difficult to reconstruct the basics of the experiment where rotation of the coil could cause a deflection in a suspended magnet and a measure of the resistance of the wire in the coils could be determined.

The apparatus consisted of two circular coils of copper wire, about one foot in diameter, placed side by side, and connected in series; these coils revolved around a vertical axis, and were driven by a belt from a hand-winch, fitted with Huyghen's gear to produce a sensibly constant driving-power. A small magnet, with a mirror attached, was hung in the centre of the two coils, and the deflections of this magnet were read by a telescope from the reflection of a scale in the mirror. A frictional governor controlled the speed of the revolving coil.

Predicting Tides

The approach of solving physical problems by representing them as a series of harmonic oscillations of different phases amplitudes and frequencies would be a hallmark of William Thompson's work. A classic example of this is his tidal prediction system which was a complex mechanical device which could simulate and integrate some 15 independent harmonic oscillations. The system is in effect a complex analogue computer. The actual mechanical construction had been developed by his brother James. From analysis of tidal

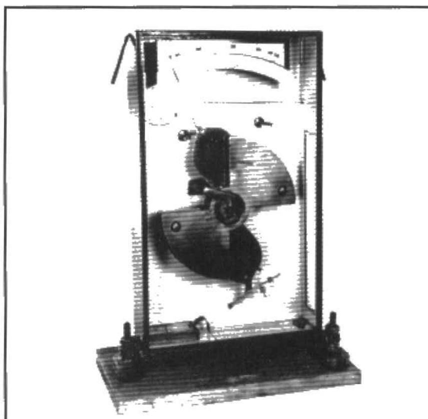


Photo 5. William Thompson's electrostatic voltmeter of 1887 based on electroststic principles. (Courtesy IEE)

readings in harbours William Thompson could determine the characteristics of each component of oscillation and use such data to predict tides by time and height with excellent accuracy. Each solution, however, was based on a series of measurements at a specific location.

Such data had also considerable relevance to a maritime nation with over 50% of the world shipping sailing under the red ensign. The large number of terms that William Thompson included in the prediction system indicated the levels of complexity he was aware constituted the earth's tidal systems.

Generating and Transmitting Electrical Power

William Thompson was also keenly involved in aspects of civil engineering – especially in the development of generating plant for electricity. In the early days of science, in 1841, William Thompson was skeptical of the efficiency of producing of electricity by any means other than by battery – electro magnetic energies were not promising.

By 1878, however, the tide was turning. CW Siemens was to note a sudden burst of enthusiasm on behalf of Sir William in his belief in the generation and distribution of electric power. At this juncture, the technology of generation was via inefficient and bulky dynamos though development by Sir William (1881) and Sebastian de Ferranti (1882) led to patents of alternator designs which were exploited jointly. After some initial distractions, the commercial enterprise of Ferranti with technical assistance from Sir William would prosper. This would also be the period of expansion of the London Underground system for which electric traction vehicles could be manufactured. On ships, alternator systems delivered provided power for safe lighting.

On Board the Lalla Rookh

The purchase by Sir William of the yacht *Lalla Rookh* – a 100 feet schooner in 1870, provided a refuge from University administration, and a laboratory for developing marine navigation aids – the principle ones being the marine compass and depth sounding machines.

The emergence of a broad range of engineering skills led to the Clyde area as the dominant shipbuilding area of the world for in 1876 more iron ships were built there than the rest of the world put together – a staggering achievement.

One of the tried and tested methods of assisting navigation was to take soundings. The conventional method, however, required the ship to slow to throw heavy weights overboard and then recover them. Many shipwrecks, however, had taken place because of infrequent soundings being taken – such as the loss of the *Schiller* in May of 1875. Sir Thompson's approach was to derive a system that used thin piano wire and smaller weights and also which had special weight loading attachments to prevent sudden release of tension in the lines following grounding of the sink weights. Such a sounding apparatus was essentially good mechanical engineering made workable by patient application and elimination of problems. Using such systems with frequent soundings, captains could sail at speed in the fog and mark their way by tracking courses of known depth on admiralty charts. There is no doubt, however, that this unit significantly contributed to the safety of sea traffic. The other major development of Sir William was that of the marine compass. Here we see the combination of speed of transit and therefore efficiency combined with safety.

Perfecting the Marine Compass

At first sight, the technology of the marine compass might appear trivial and uncomplicated. In fact developing a sound understanding of compass behaviour, especially abroad iron ships, was to occupy some of the best minds of Victorian science. The major component of work had been undertaken by Archibald Smith – a fellow student of Sir William while at Glasgow University. When Sir William took charge of the Lalla Rookh, Smith had been studying ship navigation and compasses for thirty years and succeeded in deriving a mathematical expression which could be used to correct deviation in compass measurements for a wide range of conditions. This was therefore not directly making the compass indicate accurately but compensating for this by numerical calculation. Smith was also able to compensate for a heeling ship and optimise the layout of magnetic dipole needles on the compass card in order to minimise harmonic deviations.

Following Smith's early death in 1872 – due principally to the rigours of his compass endeavours, Sir William set to work not just to refine processes of numeric correction but to develop as far as possible an inherently accurate compass. He designed the compass card to have a long period of oscillation around 42 seconds and also to have a pivot with low friction – a sapphire cup with iridium plated pivot. Permanent magnets were installed below the card to minimise the heeling error and the magnetic needles were made smaller so that the area for correction did not extend over a larger surface area.

The set of magnets strategically placed around the compass card compensated for the ship's intrinsic magnetic pattern. Various of these could be adjusted if the magnetic characteristics of the ship altered appreciably.

The design was patented in 1876 and rapidly entered production in the company of Kelvin and James White with a total of 10,000 compasses being installed in the various marine fleets of the world. Eventually the Royal Navy took up the Kelvin compass around 1889 onwards. The Kelvin marine compass, however, was indeed a fine example of a problem in measurement which had been studied in depth at a theoretical level and with the implementation of a highly practical and reliable mechanism to provide the solution. We see here also the energy and enthusiasm to take on the problem and provide a successful conclusion. The Lalla Rookh was just, therefore, another laboratory.

The Making of Lord Kelvin

In the 1880's Sir William became an influential lobbyist on behalf of the eventual government of Lord Salisbury – campaigning against Gladstone's liberal aims of home rule for Ireland. This favourable political connection, together with recognition of his noted scientific achievements led to Sir Thompson being elevated to the peerage in late 1892. Sir William adopted the title of Baron Kelvin of Largs after the river Kelvin which flowed past the University on its way to the Clyde.

Lord Kelvin was to retire from the professor of Natural Philosophy at Glasgow in 1899 and survived in moderate health till 1907, dying on the 17th December 1907. Lady Kelvin survive till 1916.

An Enduring Legacy

The world today is very much pre-occupied with the creation and distribution of energy. In an obituary note of Lord Kelvin, Joseph Larmor would relate:-

"If one had to specify a single department of activity to justify Lord Kelvin's fame, it would probably be his work in connection with the establishment of the science of Energy, in the widest sense in which it is the most far-reaching construction of the last century in physical science. This doctrine has not only furnished a standard of industrial values which has enabled mechanical power in all its ramifications, however recondite its sources may be, to be easured with scientific precision as a commercial asset...."

In relation to the development of standards of measurement Larmor continued:-

"he was also the prime mover in starting those determinations of absolute constants of nature and of numerical relations between the various natural standards, which, repeated and refined by a long line of eminent successors, are now the special care of governments, as affording the universal data on which modern exact engineering is ultimately based."

Lord Kelvin in 1896 headed a list of signatures for the establishment of a National Physical Laboratory. The outcome of this campaign was the formal opening of the NPL at Teddington near Hampton Court in 1902.

The detailed analysis of the scientific work of Lord Kelvin is difficult in the extreme – for this requires the comparison of his theory and work at a historical level to be compared with the best focus of understanding of modern physics. This is difficult to do especially for electromagnetism and also for the complexities of thermodynamics. It becomes a lot easier to commentate on specific inventions and encounters rather than, for example, comment on the scientific prejudice of Lord Kelvin in not accepting the system of equations of James Clerk Maxwell in the field of electromagnetism. This problem is probably even more acute with more recent scientists such as Feynman, where levels of theoretical physics are significantly more complex than even that of the time of Lord Kelvin.

The era of Lord Kelvin had witnessed the transformation of society and commerce by developments in science and technology – in particular of the transformation of energy, in its many forms. In particular we see the evolution of experimental laboratories as a key element of technological progress. Lord Kelvin would be quite perturbed, however, that UK Ltd had not been more successful in deriving an appropriate measure of wealth from its intellectual property rights.

Further Reading

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ELECTRONICS

Points of Contact

Special collection archive at University of Glasgow:
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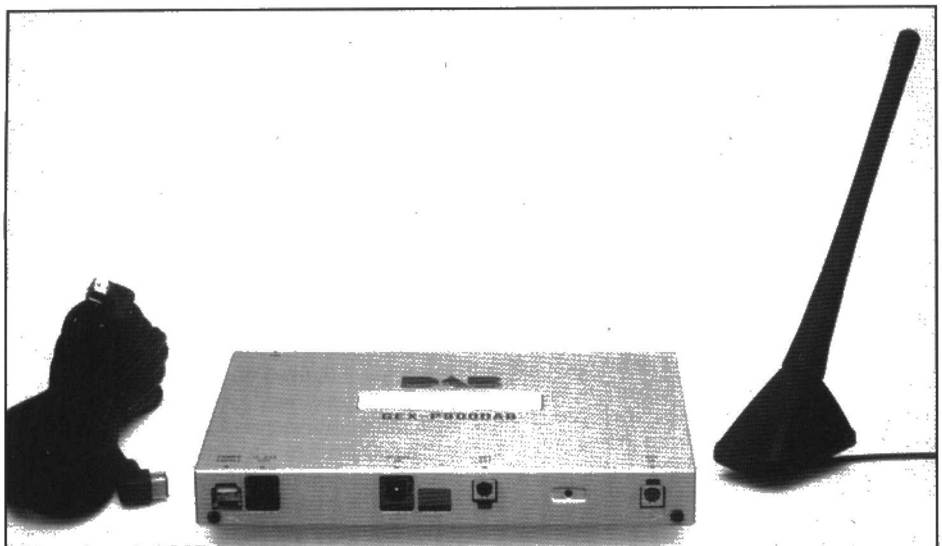
Electronics in the MOTOR INDUSTRY PART 3

In Part 3, Mike Bedford opens up the world of in-car entertainment.



Experimental DAB tuner.

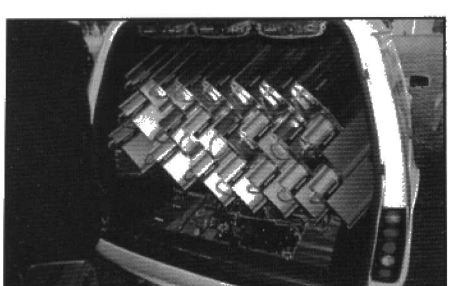
So far in this series we've painted a picture of how the motor vehicle is undergoing one of its biggest shake-ups ever. And the driving force behind today's rapid rate of change is the availability of low cost electronics and microprocessor systems. No longer are mechanical design skills the only ones required in the motor industry – today electronic design and software engineering skills are equally important. But if you thought that electronics in cars is a comparatively recent innovation, then you're seriously mistaken – the first piece of electronic equipment for cars was developed over three quarters of a century ago. In fact, that first piece of electronic kit appeared on the scene in 1922, it was invented by George Frost and – if you hadn't already guessed – it was the car radio.

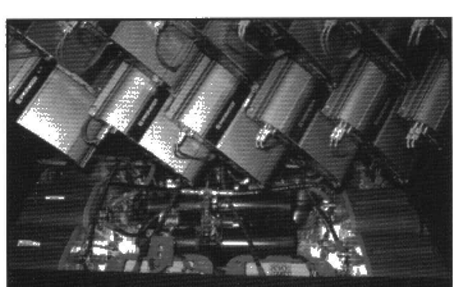
This piece of history is a useful place to start this, the third article in our series on the application of electronics in cars. For unlike the electronic systems we've looked at over the last two months which are essential to the correct operation of the vehicles in which they're fitted, the systems to come under the spotlight this month are periphery. So we won't be looking at the use of electronics to control the engine, to ensure that a car remains stable under hard braking on a poor road surface or to cut harmful emissions. Instead we're looking at those added extras which are put there to make the car more enjoyable to drive, to make your long journeys less boring, to keep you in touch with the world and to help guide you from A to B.

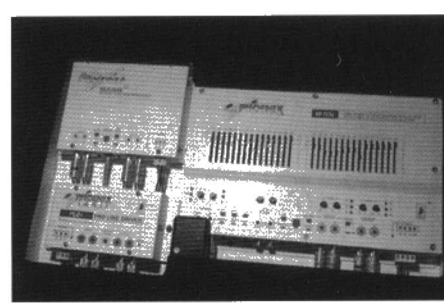
George Frost's Legacy

Although the car radio was invented way back in 1922, it didn't exactly take the world by storm in the early days. Needless to say it used valves so it wouldn't exactly have been compact and my guess is that it wouldn't have been the most reliable piece of kit imaginable either. And, of course, there would be a long wait for transistors to come along and so provide a viable alternative to bulky and fragile valves. The transistor did eventually appear on the scene in 1947 but it was some time before it became a commercial product and prices started falling. The first transistor radio was brought to the market in November 1954, just in time for the Christmas rush. It was called the Regency TR1, it was designed by the small Indianapolis TV company Idea, but at \$49.95, this revolutionary new product wasn't exactly cheap back in the mid-50s. It was hardly surprising, therefore, that Idea never became a household name. Nevertheless, within another decade, the transistor radio had become a symbol of the 60s pop culture and the car radio was, at long last, a practical and affordable piece of equipment. Perhaps it took another twenty years or more before the car radio became standard issue on virtually all cars, but with car radios now almost universal, you might think that's the end of the story. But you'd be wrong. Even the car radio is continuing to develop with clever new features being demonstrated as recently as the Motor Show in October. So, with the history lesson behind us, let's take a look at some of the more recent and innovative developments in the realm of in-car entertainment.

When radios first starting appearing in cars, the aim was to allow the passengers to enjoy the same sort of entertainment while on the move as that they enjoyed at home. But, of course, this was in a pre-television age. With the use of radio in the home now very much in decline, radio has become a uniquely mobile form of entertainment. And as such, developments in radio broadcasting technology are aimed very much at the car radio user. Perhaps the first development to come into this category was RDS which was introduced in the UK in the early 90s. YThis is the Radio Data Service which was added to standard VHF FM transmissions and can be thought of as the radio equivalent of TV's Teletext. Both allow for a small amount of data to be transmitted alongside a signal which is predominantly analogue. In all probability your car radio has RDS and you probably make use of its facilities, even though you might not be familiar with this particular acronym. RDS involves the transmission of data at 1185.5bps by phase modulation of a 57kHz sub-carrier on the normal FM signal. This data includes a code which identifies the station, the type of program being transmitted (e.g. sport, news, classical music etc.), the time and date, and even information such as the title of a track, the phone number to call for additional information etc. Exactly what this means to the user depends on which facilities the car radio manufacturer has decided to build in. In the main, however, the name of the station will be displayed on the radio and the driver can choose to have the current programme interrupted if the radio detects that a local station is about to transmit a







Kam Jagpel's 'Virtual Reality' Escort van.

traffic report or a news flash. Some radios will even re-tune to another frequency carrying the same station if you drive out of range of the one you're listening to.

RDS might have been developed specifically for car radio use but it's no longer state of the art technology. However, the next development is about to take the world of in-car entertainment by storm. With the recent media coverage of digital TV, you really can't have escaped the fact that television has gone digital in the UK. Surprisingly, far fewer people are aware of the fact that radio went digital a couple of years earlier and that it offers major benefits for mobile reception. Car radio manufacturers are now starting to release digital products, this is undoubtedly going to be the next 'must have'. At the moment, the BBC claim to have reached 60% coverage, however, a look at the coverage map will reveal the priorities – coverage is centred around the major motorway corridors. As with digital TV, a number of benefits are promised. Sound quality will be improved, there will be more channels, for the home as opposed to the mobile user there'll be graphical information to compliment the sound, and – of particular relevance to car radio listeners – reception will be relatively immune to fading and loss of signal caused by constantly changing reflections off buildings.

The Decibels Dragsters

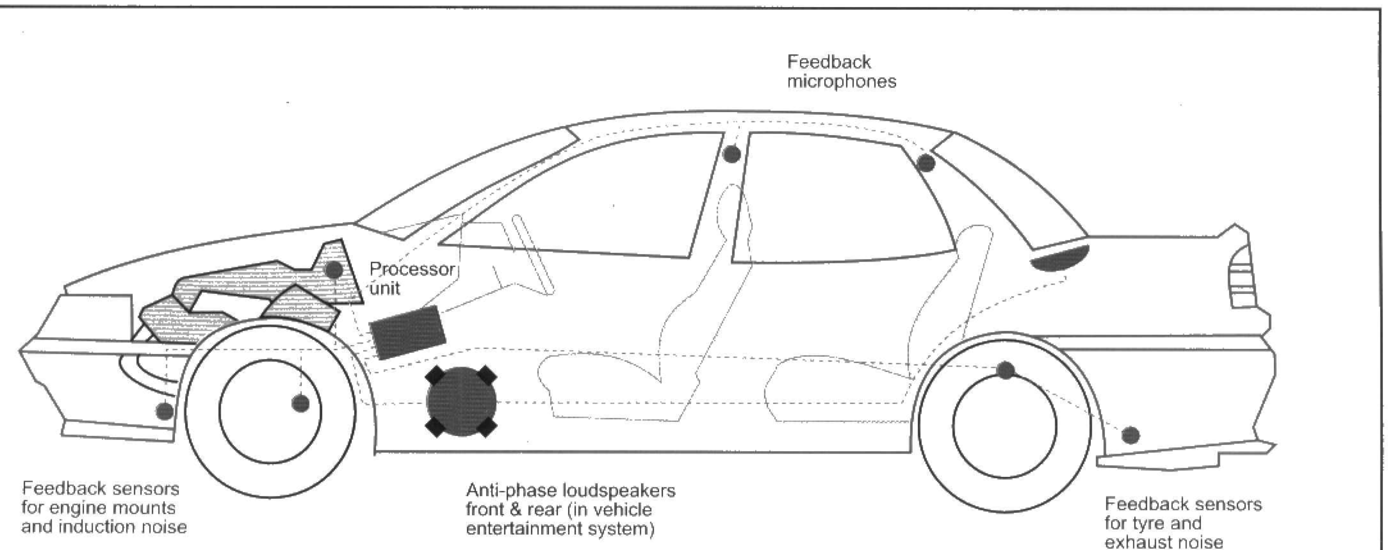
In the main, the features of an in-car entertainment system which car manufacturers will promote relate to sound quality and choice. So they'll bombard you with phrases like 'crystal clear digital sound', they'll tell you about the multiple speakers which give you full surround sound and they'll point to the CD multiplayer which will provides you with hours of music. However, I thought it would also be interesting to take a quick look at that group of enthusiasts who have a very different set of priorities. These are the people to whom a good car entertainment system is a loud car entertainment system. These are those dedicated individuals whose quest is to achieve the highest possible sound pressure level. These are the decibel dragsters.

Kam Jagpel's pride and joy is 'Virtual Reality', an Escort van with some serious audio kit shoe-horned into the back. Sponsored by Pioneer, the kit in question includes a 50 disk CD autochanger, six speakers in each of the front doors powered by a pair of 600W amplifiers, and 22 subwoofers in the back, each with its own 600W amplifier. Oh, and there are also banks of batteries, to power this 14.4kW set-up. The end result is a massive 155.9dB, enough to gain Kam the British record for sound level in a vehicle. But what does 155.9dB sound like? For a start let me point out that the noise tables used by industry to limit employees exposure to damaging sound levels only goes as high as 102dB – this is the level at which more than a quarter of an hour per day will cause noise induced hearing loss. And remember, that every three decibels corresponds to a doubling of the acoustic power. Enthusiasts point out, however, that industrial noise is far more harmful that music, especially if most of the musical power is in the bass. Nevertheless, whatever the frequency, a sound pressure level of 150dB is enough to interfere with your nervous system and, to put no too finer point on it, at this level you simply can't move. But even Kam Jagpel's 155.9dB is a good bit short of the world record which currently stands at 172.3dB – that's about 40 times louder than Virtual Reality. Also bear in mind, that because of the inefficiency of amplifiers and speakers at this sort of level, it can require as much as ten times more amplifier power to get a 3dB improvement. And it isn't just an electronic challenge to produce a seriously loud vehicle either. The aim of the decibel dragsters is to generate a high sound pressure level inside the vehicle. But if you try pumping this sort of audio power inside an ordinary vehicle, the sides flex and the whole car ends up acting as a huge speaker. In other words, you end up loosing sound level in the car and entertaining or annoying the neighbourhood instead. The solution is to reinforce the walls. And we're talking some rather serious reinforcing – six inches thick, steel plate, medium density fibre board, even concrete.

Noise Cancelling & Noise Synthesis

If you've got an amplification system like the one we looked at in the previous section, you're not going to mind too much if your car sounds like a tractor. Just pump up the volume a bit and you'll be totally oblivious to the fact that the engine is about to breath its last. If, on the other hand, you like to listen to your car entertainment system at a more modest level, then engine noise and road noise can seriously impact your listening pleasure. Although cars are certainly much quieter than they were, with the possible exception of the legendary Rolls Royce saloons, there's no such thing as a silent car. Or is there?

Curing the problem of noise using conventional methods is a process in which the law of diminishing returns applies. The fact that you need to spend more and more to effect increasingly small improvements is evident from a Rolls Royce's price tag. And it's not exactly in keeping with today's environmental concerns to use a huge engine so that it will rarely be much more than ticking over and thereby comparatively silent. Lotus feel that there's a better way and it's called adaptive noise control. Others refer to this approach as active noise cancelling – here's how it works. Most of the noise which you hear from inside a car comes from the engine, the exhaust and the wheels. So, if you place microphones under the bonnet, near the exhaust and near the wheels, and if you then phase shift the signals by 180°, amplify these signals to the right level and feed this phase-shifted audio to speakers in the cabin, you should be able to cancel the sound entering the cabin. The tricky part, of course, is knowing how much to amplify the signals since if the level isn't right, then noise cancelling won't be optimum, in fact, you could even end up making things worse. So, in addition to the microphones which sample the offending sound, there are also feedback microphones in the cabin to sense the efficiency of the noise cancelling system and provide the information needed to adjust the signal levels accordingly. Needless to say, the box of tricks which controls the noise

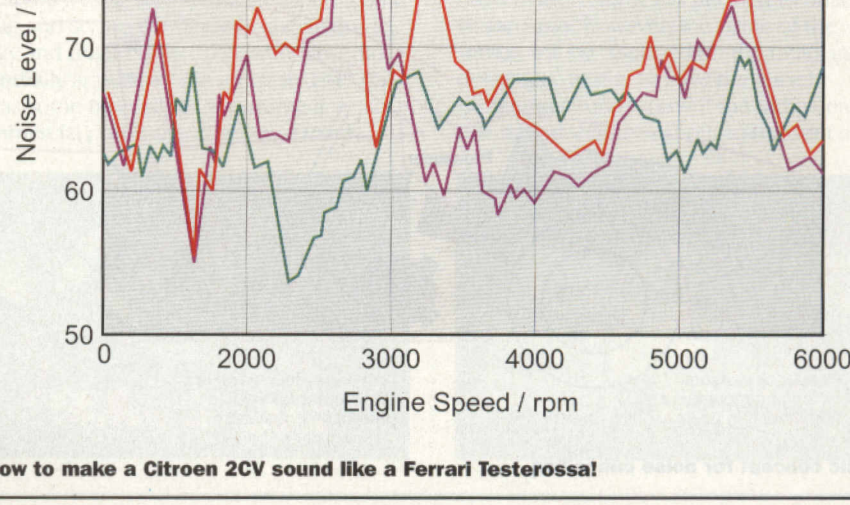


Basic concept for noise cancelling.

Interior of BMW 750iL with visual display.

cancellation is a digital signal processor and impressive results are claimed. Up to 20dB of reduction in the level of low frequency noise has been reported although this sort of system is not as effective for eliminating high frequency noise. The reason for this is quite obvious really. With a low frequency sound, the wavelength is sufficiently long that effective cancelling can occur over a reasonably large area – certainly it's possible to cover an area the size of a car saloon. With a higher frequency and therefore a shorter wavelength, if the system is able to provide a signal to cancel the noise at the location of your left ear, your right ear could well be in a position of constructive interference and therefore hear noise which is twice as loud. For this reason, an alternative approach is being pursued which involves eliminating the sound at source. This, additionally, will also reduce the ambient noise level outside the car. One example is the use of active engine mounts which move in anti-phase to the sampled vibrations of the engine.

Interestingly, not everyone wants a silent vehicle – the tendency of some motorcyclists to deliberately tamper with their silencers is evidence of this. Sports car drivers in particular, often want their car to have that characteristic sound of a powerful V8 engine. But, as we saw a couple of months ago, new technology is allowing engines to be made smaller without affecting performance. So, for example, many of the mid-range sports cars on the British market today have two litre engines yet are able to produce 175bhp or better. The result, is that these cars don't sound like people expect high performance cars to sound. It's not so much that they're quiet – EEC regulations require this – but that the quality of the sound is wrong. It's perhaps not overstating it too much to say that some of these vehicles sound more like sewing machines than sports cars. It was in an attempt to remedy this perceived problem that Lotus started experimenting with a derivative of their adaptive noise control system. Called noise synthesis, the approach involves processing the noise to make it more 'satisfying' instead of trying to get rid of it using phase shifted 'anti-noise.' Simply, this involves altering the amplitudes of the various harmonics of the basic engine sound. Apparently a Citroen 2CV has been made to sound like a Ferrari Testerossa. If the system could also make it look, perform and handle like one, I think they'd be onto a winner!



How to make a Citroen 2CV sound like a Ferrari Testerossa!

The User Interface

Some years ago, I met a radio amateur who had a full short-wave radio station set-up on his car including a Morse key bolted to the underside of the dashboard. His boast was that he could hold the steering wheel with his knees, change gear with his left hand and continue to send Morse with his right hand. Clearly times have changed. For a start, communication to and from cars is no longer the domain of radio amateurs and well-healed businessmen who could afford the first generation of car phones. Secondly, the law now takes a very dim view of the sort of activity I outlined above. As we're all aware, even holding a microphone with one hand while driving is enough to gain you a conviction and a few points on your licence. If you have a cell phone installed in your car – as opposed to simply putting your mobile on the passenger seat – it will, almost certainly feature hands-free operation. But what about dialling the number on a tiny cellphone keypad? Arguably this is more distracting than simply holding a microphone. And the same applies to in-car entertainment systems. OK, perhaps the push-button channel select and the automatic search function on most car radios means that tuning to a new station doesn't keep your eyes off the road for too long, but what about finding a track on a CD? Some car manufacturers are now turning their attention to finding a safe method of controlling all these bits of electronic paraphernalia.

The BMW 750iL saloon, for example, has a colour LCD screen built into the fascia and a number of buttons on the steering wheel. And this interface is used to control just about everything. In fact, whenever the car is stationary, the display can also be used to display television pictures and Teletext information. But returning to its use as a centralised control interface, the GSM phone, the radio, the six disk CD autochanger, the digital sound processor, and even the auxiliary ventilation system are all controlled via this screen. For example, the GSM cellular phone can store the telephone numbers for up to 100 people. By scrolling through a list of contacts on the LCD screen using the buttons on the steering wheel, an entry can be selected and the number dialled without either hand ever leaving the steering wheel. Of course, the one fly in the ointment is that the driver still has to look at the screen in order to select the correct number. But even this distraction may be avoided if research by Rover and others into head-up displays ever comes to fruition. With this approach, the information is projected onto the windscreen, focussed at some distance in front of the car so that the driver doesn't have to look away or even refocus his eyes.

Jaguar have adopted a different approach to keep the driver's eyes on the road in their new S-type saloon which debuted at the 1998 Motor Show in October. Here, the driver simply talks to the car, giving it instructions such as which track of which CD to play or what telephone number to dial. The system will verbally repeat the request to the driver and ask him to confirm it.

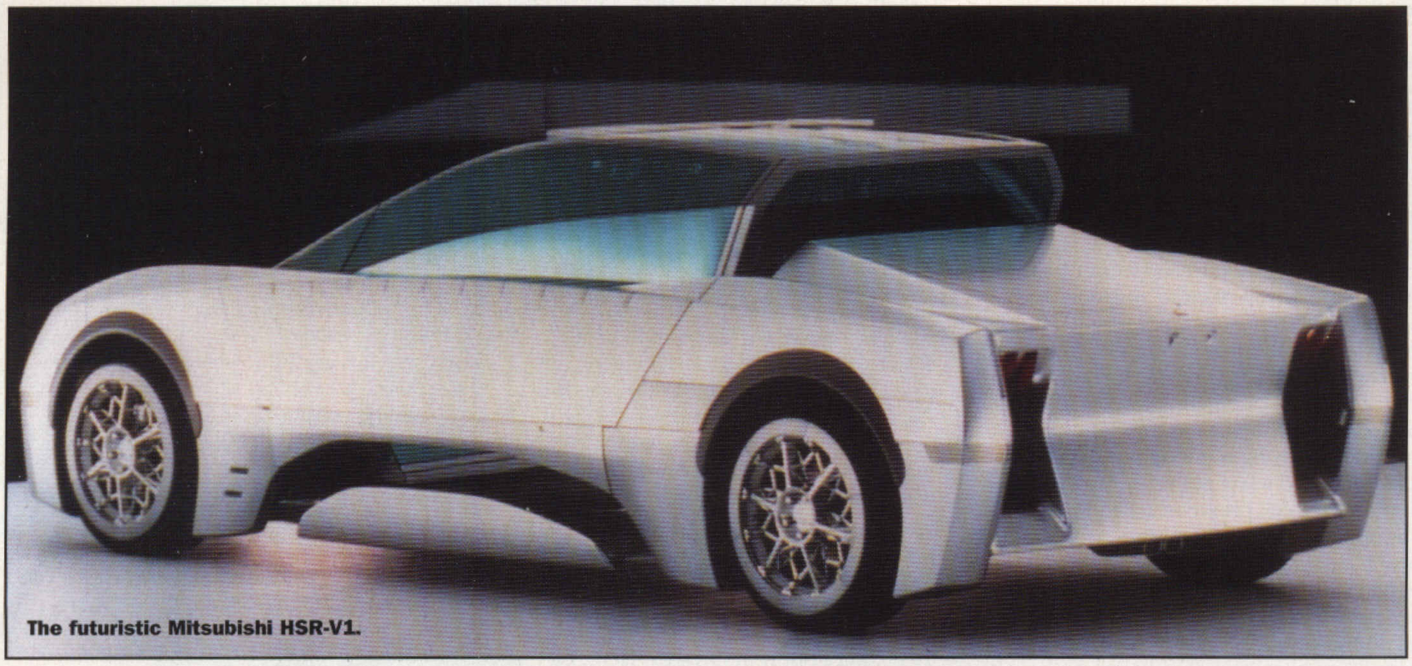
Navigation Systems

How often have you heard that classic phrase, "I don't want anything fancy, I just want a cheap and basic car which will get me from A to B"? Ironically, therefore, the cars which are most likely to get you from A to B with the minimum of hassle are those luxury saloons which boast all the bells and whistles. Navigation systems are certainly on the way but, as yet, only if you buy a pretty serious motor. Let's see what's on offer.

If you're a serious hiker, a hot air balloonist or just someone who has to have the latest high tech wizardry, you'll be fully aware of GPS. The global positioning system consists of a constellation of 24 satellites each transmitting periodic signals to the earth. Each of the satellites is synchronised with the others so the signals transmitted by each of the satellites are sent at precisely the same time. Now, by comparing the time at which signals are actually received, a ground-based receiver can work out how far it is from each of these satellites and hence where it is on the earth's surface. This is accurate to within 50-100m although it could be accurate to 1-5m if the US government hadn't implemented selective availability. This 'feature' slightly disrupts the timing of the signals in a pseudo random sequence such that only receivers belonging to the military – which know the sequence and can therefore made adjustments – can use the system to is maximum design accuracy. Nevertheless, 100m is good enough for most people and small entry-level hand-held units now cost about £100.

Car navigation systems use GPS but are much more sophisticated than the small receivers intended for use on foot. Let's look at the GPS system fitted as standard to the BMW 750iL. The GPS receiver determines the position of the vehicle in the usual way but rather than just displaying the national grid reference or the latitude and longitude, it plots the position onto a digitised map which is loaded from CD-ROM and is displayed on the LCD monitor. However, the system does far more than just tell you where you are – you can also enter a destination and the system will work out the best route and guide you accordingly. In addition to giving just the

Interior view of Jaguar S-type.



The futuristic Mitsubishi HSR-V1.

destination, the driver can also instruct the system to take specified roads, or to go via some intermediary location. And, in keeping with safety initiatives, as an alternative to giving the driver instructions on the screen, the system will give voice commands including advanced notice of junctions.

This sort of navigation system is good if road conditions are perfect. On the UK's congested motorways, however, it's often a very different story – there's little point in your GPS system telling you that the shortest route involves a 15 mile stretch of the M25 if the traffic on that stretch of road is at a stand-still. By the time you've arrived at the trouble spot, it can often be too late to take an alternative route. This is where the Trafficmaster system comes to the fore. The system has two elements. First of all there are sensors along all the UK's motorways and 400 miles of other major roads. These detect traffic speed and transmit a warning back to the control centre if the average speed drops below 30mph. Warnings of traffic black spots are then transmitted via a national network of transmitters, once again concentrated on the motorways and trunk roads and messages are displayed in vehicles equipped with a Trafficmaster receiver.

The Ultimate

Last month, we introduced you to Mitsubishi's concept vehicle the HSR-VI. With its wide range of sensors, this futuristic car is fully aware of its surroundings and will actually intervene in the case of a dangerous or illegal situation occurring. So, for example, if will override the steering and so take preventative action if a collision is imminent and it will apply the brakes if the driver attempts to pass a no entry sign. With such sophisticated systems, it's appropriate to question whether a human driver is somewhat redundant. Well, in a sense a driver is indeed surplus to requirements, for in addition to the standard driver-operated mode in which automated systems just lend a hand, the HSR-VI also features a fully automatic driverless mode. So if you want the ultimate in in-car entertainment, this is surely the way to go.

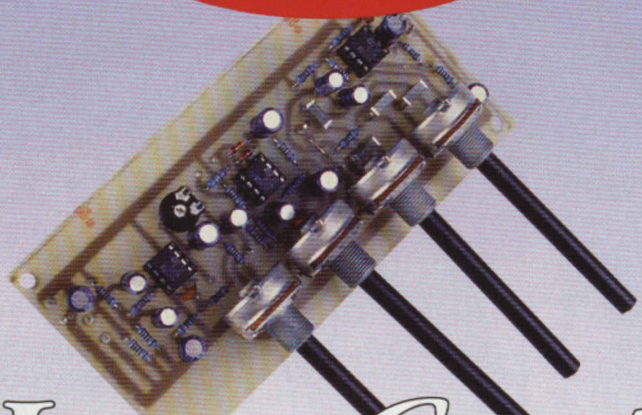
As we saw last month, tests into automated highways have already proved successful. Here, vehicles are formed into tightly packed groups, travelling at high speed to achieve maximum road utilisation and safety. It is on this type of automated highway that the HSR-VI would switch into its automated driving mode. And with the chores of driving removed, the driver can now sit back and enjoy the journey. To facilitate this, the position of the driver's seat changes to emphasise comfort rather than visibility. So, the seat reclines, the roof lowers for improved aerodynamic properties and the steering wheel retracts. In place of the steering wheel, a 12.1in display lowers from the ceiling – this is the heart of the car's information and entertainment system. In terms of essential information, data relating to the automated driving mode, weather and road conditions, and navigational information can all be displayed. However, if you want to forget all that for a while, the screen is also capable of supporting access to the Internet, telephone and fax, and you can even enjoy the TV or a movie. And all of this is controlled using a so-called multi-dimensional controller, a sort of tracker ball which sits in the arm rest between the two front seats.

Next Month

Well, that's all we have to say about the use of electronics to pamper the driver. Next month, in the fourth part of this series, our emphasis is quite different. You certainly won't come across in-car entertainment systems in the vehicles we'll look at next month, although electronics and computer systems play no small part in their design and operation. Next month, we're going to be concerned specifically with the use of electronics in the quest for speed. But we're not talking esoteric production cars here, we're talking of cars which are designed for the sole purpose of going fast, very fast indeed. In other words, we'll be looking at how electronics played its part in last year's successful attempt on the land speed record and how Formula One racing is now a very high tech sport.

Interior view of Mitsubishi HSR V.

PROJECT



Low Cost GUITAR PREAMPLIFIER

Gavin Cheeseman describes a low-cost preamp for home and practise use.

Introduction

There are many different types of guitar amplifier on the market from simple low cost practise amps to professional units costing hundreds or thousands of pounds. With such a wide choice of off-the-shelf equipment you maybe forgiven for wondering why anyone would want to resort to building a preamplifier. However, right from the beginnings of electromusic, there has been a strong urge to experiment with different sound effects and home built equipment provides an excellent method of achieving this. Of course, technology has come a long way since the 1970s but recently, there appears to have been a resurgence of interest in simple analogue equipment.

In this article we look at the construction of a simple preamplifier unit that can be used in combination with a power amplifier to form a basic guitar amp. The circuit makes use of standard op-amp technology and is intended for those who want a simple, no nonsense preamp for home and practise use. The unit is designed to allow some flexibility to cater for a range of operating conditions and is intended as a starting point for those who wish to experiment with simple guitar effects.

The circuit

Referring to Figure 1, it can be seen that the circuit is based around three operational amplifiers. The device chosen for this application is the LF351 which is a FET input type. The circuit is designed to operate from a single 12V supply. This is connected between P1 (+V) and P2 (0V). The input signal is applied between P3 (i/p) and P4 (0V). Capacitors C19 to C22 act as supply de-coupling. C19 – C21 provide filtering at high frequencies and should therefore positioned as close as possible to the IC's whereas C22 provides general bulk de-coupling for the supply rails. For the most part, resistor R1 sets the input impedance. The value shown is arbitrary and in practice may be selected depending on the type of input being applied to the preamplifier. Initial amplification is performed by IC1. Capacitor C2 couples the input signal to the non-inverting input of IC1 whilst blocking DC components. Pin 3 of IC1 is biased at approximately half of the supply voltage via resistor R4. The half supply reference voltage is set by R2 and R3 and is de-coupled by C1. The gain of the stage is set by resistors R5 and R6 together with pre-set variable resistor VR1. VR1 enables the gain to be reduced where large input signals may otherwise result in overload and clipping. Capacitor C3 rolls off the response of the circuit at low frequencies and blocks DC whilst C4 provides a degree of high frequency roll-off. The output of IC1 is coupled to the next stage via C5. The drive level to the next stage is user adjustable via a panel mounting potentiometer VR2. The top end limit of this control is set by R7. The next stage of amplification is carried out by IC2. This stage provides a 'fuzz' effect by deliberately clipping the signal. R8 – R10 are bias components with C6 providing de-coupling and C7 acting as inter-stage coupling. The fundamental gain of this stage is set by R11 and R12; however, above a specific signal level where diodes D1 and D2 start to conduct the gain rapidly diminishes. D1 and D2 therefore introduce a non linear element which is rich in harmonics. It is the increased harmonic content that results in the characteristic sound of the fuzz effect which is widely used in rock music. Capacitor C10 couples the output of IC2 to the next stage. VR3 is a panel mounting control that allows the user to control the final output level. The next stage is a simple tone control stage. Capacitors C11 and C12 together with VR4 form a treble control circuit whilst C13, C14 and VR5 control the bass response. Both VR4 and VR5 are panel mounting potentiometers. R14 helps to isolate the treble control and bass control circuits. The output from the tone control circuit is fed to the final amplifier stage based around IC3 via coupling capacitor C16. R15 – R17 are used to provide a half supply reference voltage for the operational amplifier. C15 provides decoupling for the reference voltage. C17 rolls off the gain of the stage at low frequencies whereas C18 produces a similar effect at high frequencies. At audio frequencies, the gain of the stage is set by R18 and R19. Capacitor C23 couples the output of IC3 to terminal P8 where it is made available to the user.

PROJECT RATING 2

Circuit Construction

The circuit can be built on a printed circuit board. Figure 2 shows a suggested layout as used for the prototype unit, and the component overlay. It is recommended that single sided fibreglass copper clad board is used to make the PCB.

Insert and solder the components onto the PCB referring to the layout diagram. It is best to start with the low profile components such as IC sockets, resistors and diodes. The IC sockets are inserted such that the position of the notch at one end of the socket corresponds with the outline shown on the PCB overlay. Do not insert the IC's into the sockets until all other components are in place. Wire link, LK1 can be made from a

component lead offcut. Next fit the capacitors. The electrolytic capacitors are polarised and therefore must be inserted with the correct orientation. The position of the capacitor positive lead is marked on the PCB layout diagram with a positive (+) symbol; however the capacitors themselves are usually marked with a negative symbol on the side of the component indicating the position of the negative lead. Therefore the lead of the capacitor marked with a negative (-) symbol should be inserted into the hole furthest away from the positive (+) symbol on the PCB overlay. This is particularly important as incorrectly connected electrolytic capacitors can explode. The ceramic and 'poly layer' capacitors are not polarised. Please note, capacitors C4, C9 and C18 are intended to limit the high frequency response of the circuit and are not fitted in all applications.

Insert the PCB pins into the PCB using a hot soldering iron. If you are not used to this procedure it can take some practice. First insert the pin into the hole in the PCB from the track side. If the hole is the right size, it will not be possible to insert the pin fully by hand. Once the pin is inserted apply a hot soldering iron to the pin and gently press it into position until the head is in contact with the track side of the PCB. When the pin is at an appropriate temperature very little pressure should be needed. Do not apply excessive force as this may result in damage to the soldering iron and may present a safety hazard. When the pin is correctly in position, solder the head of the pin to the PCB track. If necessary the pins can be straightened after insertion using a pair of long nosed pliers.

The four panel mounting potentiometers VR2 – VR5 should be fitted last (with the exception of inserting the IC's). These may be connected in various ways depending on the mounting arrangement for the PCB etc. The potentiometers may be inserted directly into the holes on the PCB and soldered into position or alternatively they may be wired off board. If the potentiometers are mounted off board care should be taken to ensure that the connections from the potentiometer are made to the same pads as when the devices are directly mounted. This is illustrated in Figure 3. The potentiometer pads are marked 1, 2 and 3 on the component overlay for ease of identification; these correspond to high end, wiper, and low end respectively. Where the potentiometers are mounted off board it is recommended connections are kept as short as possible to avoid extraneous pick up. Screened leads can be used if necessary but in most cases, if the leads are short there should be little problem.

Finally insert the ICs into their respective IC sockets ensuring that the position of the notch at one end of the IC corresponds with that in the socket.

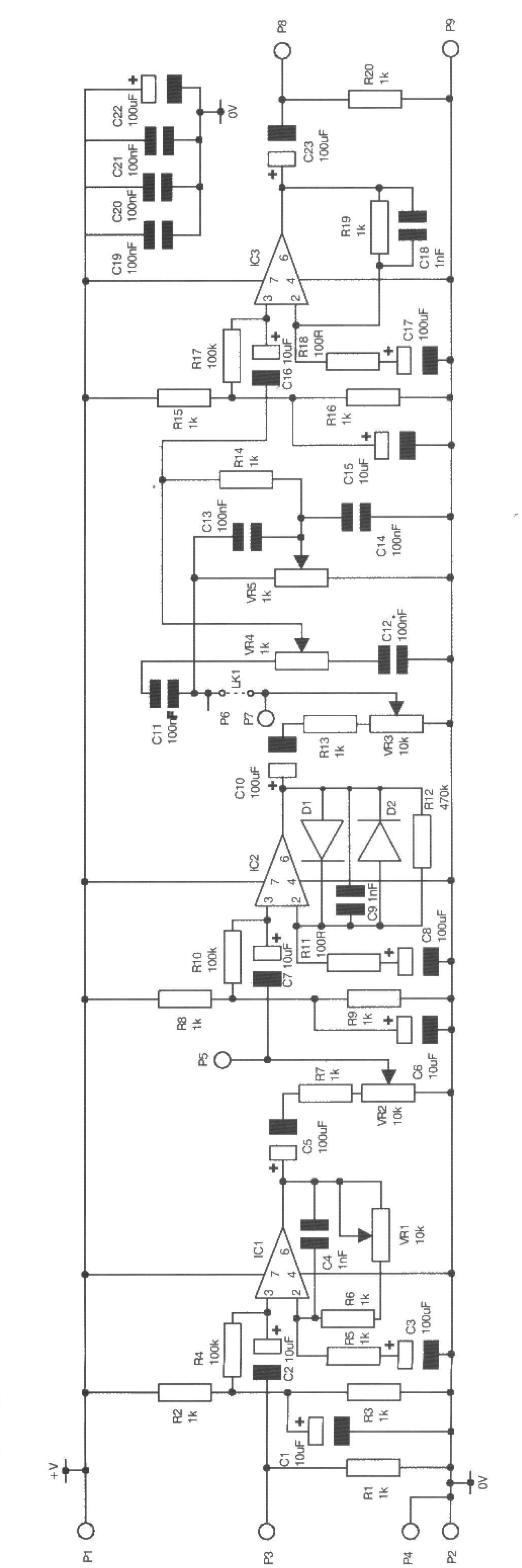


Figure 1. Guitar preamplifier circuit diagram.

Alternative Methods of Construction

If you do not have facilities to make a PCB, the circuit may be built on matrix board, either with or without strips. Because the circuit contains high gain stages, it is important to pay attention to layout. Incorrect layout may result in oscillation or other forms of instability. When using matrix board without strips it is usually a good idea to take all supply connections back to the same point making use of star earthing techniques as far as possible. Use thick wire for the supply connections. The use of wiring pens is probably not the best method for this type of circuit. Keep all wiring runs as short as possible and avoid running output wiring close to that of the circuit input. It is best to layout the circuit sequentially running from input to output as this helps to keep the output away from the input. Ceramic de-coupling capacitors should be positioned as close to the relevant IC supply pins as possible. Bulk de-coupling capacitor, C22 is probably best positioned at the point where the supply is connected to the circuit.

Testing the Preamplifier

Before applying power to the unit, it is a good idea to double check your work to make sure that all of the components are correctly fitted. In particular, check the soldering to ensure that there are no dry joints or solder short circuits. If you have a multimeter, measure the resistance between the supply rails before applying power. This will show up any unnoticed short circuits between the supply rails. The resistance may initially be very low due to capacitors in the circuit but as these begin to charge the resistance should rapidly increase.

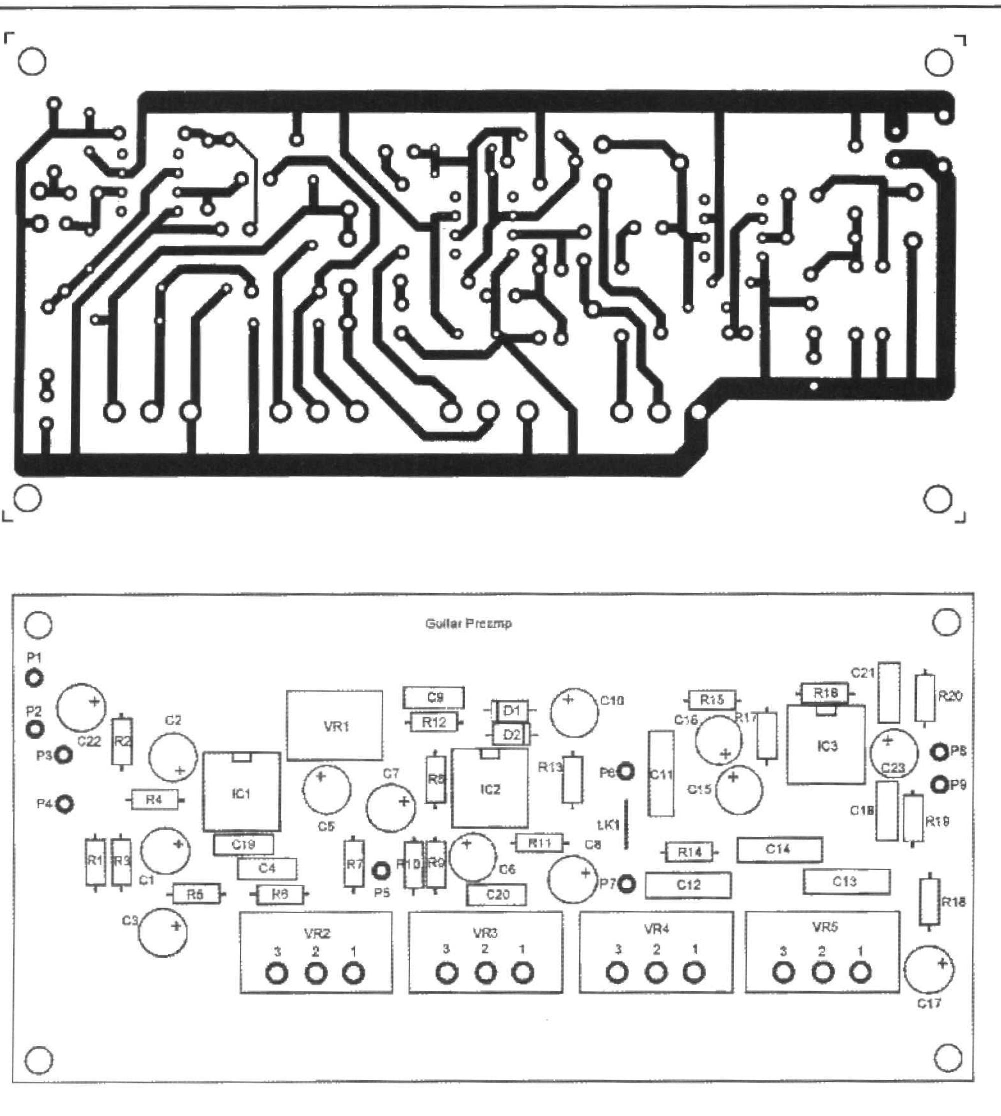


Figure 2. Suggested PCB Layout and component overlay.

The wiring diagram for the preamplifier is shown in Figure 4. The unit will operate from a 12V regulated power supply. Power supply connections are made to terminals P1 (+V) and P2 (0V). The input is connected between P3 (i/p) and P4 (0V) and the output is taken from P8 (o/p) and P9 (0V). It is recommended that a suitable fuse is connected in series with the +V supply line as this reduces the risk of damage to the circuit and power supply if a fault should occur. A 100mA F type fuse should be adequate.

If you have a signal generator and oscilloscope these can be used to check the operation of the circuit. Set all of the preamplifier's variable controls to centre position. Connect an AF signal generator (sine wave) to the input of the circuit. It is recommended that the maximum input level does not exceed 2V peak to peak. The frequency should be in the audio range; 1kHz is fine.

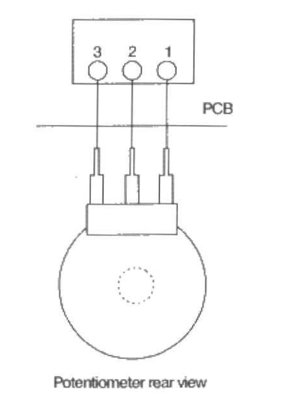


Figure 3. Wiring the panel mounting potentiometers to the PCB.

Monitor the output of the circuit using an oscilloscope or a pair of high impedance headphones. Gradually increase the level of the input signal until an output can be detected. At low input levels the output signal should be sinusoidal (Figure 5), corresponding to a pure tone in the headphones, but as the level is increased, a point should be reached where diodes D1 and D2 start to conduct. At this point some distortion should be introduced. If you are using an oscilloscope it will be seen that the waveform starts to square off as shown in Figure 6. If you are using headphones the output should start to sound rough. Back off the input level until the output reverts to a pure sine wave. Adjust pre-set variable resistor VR1. There should be a corresponding change in output level and above a certain point distortion should be introduced. Set VR1 back to central position and adjust VR2. A similar effect should result. Both VR1 and VR2 affect the input level to IC2 (the soft clipping stage). In practice, VR1 will normally be set up when the unit is installed whereas VR2 is controlled by the operator. VR3 adjusts the level after IC2. This allows the output level to be adjusted whether or not distortion is present. Check that when VR2 is set to produce distortion, it is possible to control the output level of the circuit between zero and maximum using VR3. If all is well, check the operation of the bass and treble controls. The effect of these can be seen by adjusting the frequency of the input signal over the range 20Hz to 20kHz. Adjusting VR4 to the fully clockwise position should result in a peak in treble response (an increase in signal level at high frequencies). Conversely setting the control to the fully anti-clockwise position should result in the signal level being cut at high frequencies. Similar tests can be carried out to check the operation of bass control VR5. This time the effect should be noticeable at low frequencies.

If you do not have access to a signal generator, then a guitar or other audio source can be used. Obviously the effect of adjusting the various controls will be modified depending on the signal level.

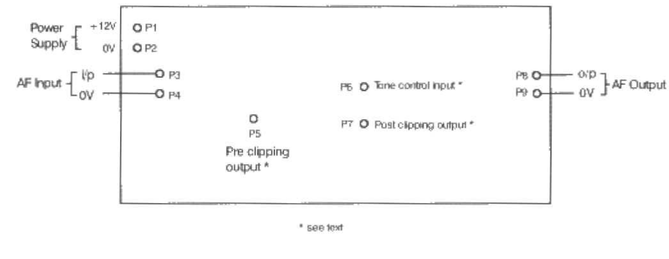


Figure 4. Preamplifier wiring diagram.

Using the Preamplifier

The preamplifier is an open ended design that can be used in a variety of different situations. It is fundamentally intended for those who wish to experiment with different sound effects in the home or practice environment. When used in combination with a simple guitar transducer (e.g. stock code BM97F) and a small power amplifier, the circuit provides a simple method of giving an acoustic guitar an 'electric' sound. The circuit design is not optimised for low noise performance and cannot be expected to mimic the classic valve amp sound.

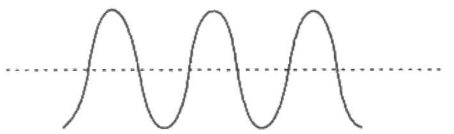


Figure 5. Example of sine wave output signal.

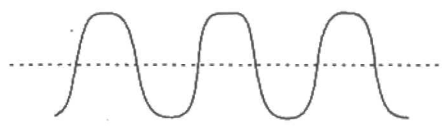


Figure 6. Example of output with fuzz effect.

The circuit can be used to drive a variety of different types of power amplifier. Before connecting the unit to a power amplifier check that the output level is appropriate and will not overdrive the amplifier. If you are not sure set VR3 to minimum and slowly increase the setting until an appropriate output level is obtained. The value of resistor R13 may be modified to give the desired maximum volume setting. An arbitrary value of 1k has be specified to provide a starting point and is suitable for power amps accepting a relatively high input level. For use with more sensitive power amplifiers, the value should be increased. The value of R7 may also be modified to provide a higher or lower signal level to IC2. For example, this may be necessary to give VR2 the most appropriate adjustment range when driving the input at a high level. The response of the tone controls can easily be changed by modifying the values of capacitors C11- C14.

The preamp circuit uses capacitive coupling to allow simple operation from a single rail power supply. This, however, introduces a disadvantage in that a pulse is produced at switch on as the capacitors charge. Therefore it is recommended that the input level control of the power amplifier is set to minimum at switch on. An alternative is to use a speaker protection circuit to delay connection of the loudspeaker at switch on. Do not connect the input or output of the preamplifier circuit to equipment with a DC offset as this may result in the coupling capacitors being reverse polarised or over-voltaged. For safety reasons all equipment must be fully isolated from the mains supply.

PCB pins are used for inputs and outputs to allow flexibility. In most cases, the input will be connected via a jack socket. Output connections may be wired to a socket or connected directly to the input of the power amp stage. Inputs and outputs should be suitably screened to reduce pickup of hum and other unwanted noise. It is important to avoid earth loops between equipment. These are created by multiple earth paths and can produce very loud hum indeed. Ideally, input and output earth connections from different pieces of equipment should be kept separate and should only join at one point of origin.

As mentioned, the input impedance of the preamplifier is primarily set by R1. A relatively low value has been specified as a low impedance helps to reduce stray signal pickup. In practice, the specified value may be inappropriate. If this is the case the value of R1 should be changed to suit the source impedance. If required, resistor networks can be wired to the input. These may be switched via suitable input jack sockets or a selector switch to provide different input impedances or to allow for various input levels. This type of arrangement is illustrated in Figure 7.

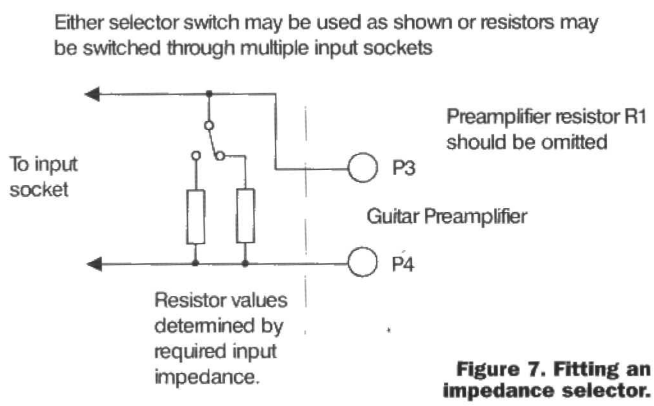


Figure 7. Fitting an impedance selector.

In some situations, it may be advisable to bypass the soft clipping stage (IC2) when the fuzz effect is not in use. This can be achieved by omitting wire link LK1. The input to the tone control stage on P6 can then be switched between pre and post fuzz by making use of terminals P5 and P7.

In addition to the soft clipping effect produced by IC2 and associated components, further distortion can be introduced by driving IC3 into clipping. This produces a much harsher form of distortion. If you wish to use this technique, it will be necessary to ensure that the output signal from the preamplifier is suitably attenuated before it is applied to a the input of a power amplifier (Figure 8).

Housing the Preamplifier

The preamplifier can either be housed in its own case or alternatively can form part of a complete guitar amplifier. The PCB layout includes four M3 fixing holes for mounting purposes. When mounting the PCB, take care not to short any of the tracks. If necessary, a 0V connection may be made to the case from P2. Potentiometer controls VR2 – VR4 may be mounted directly onto the housing and wired to the PCB. Alternatively, if the controls are mounted directly onto the PCB, these can be bolted to a suitable bracket, which is in turn fixed to the housing. The shafts of the potentiometers may be cropped to the appropriate length and fitted with suitable knobs. A quick glance through the Fixings and Hardware section of the Maplin catalogue will show that many different types are available.

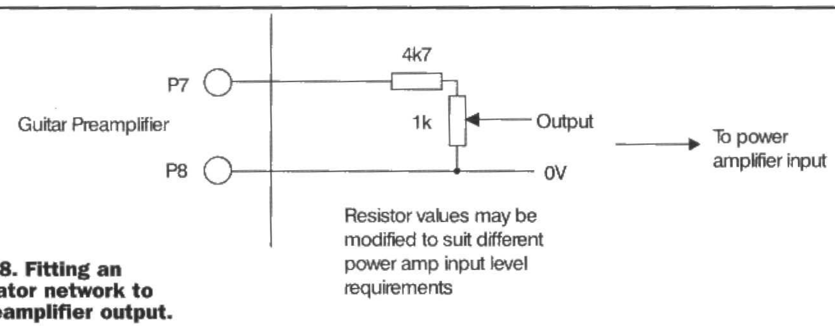


Figure 8. Fitting an attenuator network to the preamplifier output.

PROJECT PARTS LIST

RESISTORS

R1-3, 5-9, 13-16, 19, 20	1k Min Res	14	M1K
R4, 10, 17	100k Min Res	3	M100K
R11, 18	100R Min Res	2	M100R
R12	470k Min Res	1	M470K
VR1	Hor Encl Preset 10k	1	UH03D
VR2, 3	Pot log 10k	2	FW22Y
VR4, 5	Pot Lin 1k	2	FW00A

CAPACITORS

C1, 2 , 6, 7, 15, 16	Genelect 10μF 63V	6	AT77J
C3, 5, 8, 10, 17, 22, 23	Genelect 100μF 16V	7	AT40T
C4, 9, 18	Ceramic 1000 (see text)	3	WX68Y
C11-14	Poly Layer 0.1	4	WW41U
C19-21	Minidisc 0.1μF 16V	3	YR75S
	Semiconductors		
IC1-3	LF351N	3	WQ30H
D1, 2	1N4148	2	QL80B

MISCELLANEOUS

	DIL Socket 8 pin	3	BL17T
P1-9	Pin 2145	9 pins	FL24B

Words of SCIENCE

PART 5

The Buzzword Phenomena

by Gregg Grant

Introduction

Buzzwords are very much a part of our information intake these days. Whatever your source of news on current affairs, your profession, hobby or sport, your glancing through it will have resulted in your ingesting more than anyone's fair share of buzzwords.

In fact to many people, it seems, entire areas of expertise these days consist of little else BUT buzzwords. In some cases of course they're confusing buzzwords with scientific and technical *Jargon* and vice versa. So what *is* a buzzword, and who came up with jargon as a descriptive noun for techno-speak?

When Buzz Becomes Jargon

The ninth edition of the Concise Oxford Dictionary - ' the world's most trusted dictionaries' according to its blurb - describes buzzword succinctly: 'A catchword, a slogan, a fashionable piece of technical jargon.' Collins English Dictionary - much favoured by the 'New Scientist' according to the publicity puff in my copy - is almost equally as brief, detailing buzzword as ' . . often originating in a particular jargon that becomes a vogue word in the community as a whole or among a particular group.' So far, so clear.

What about jargon however? The Concise Oxford describes it as ' words or expressions used by a particular group or profession,' whilst Collins defines it as ' a specialised language concerned with a particular subject, culture or profession.' Techno-speak in other words. The word's origin is unknown, although it possibly derives from *Jargoon,* an eighteenth century word meaning 'of the golden colour.' Equally, some authorities are of the view that it derived from an underworld expression meaning - roughly - 'special.'

Whatever its origin, it is as extensive in electrical and electronic engineering as in any other specialised field. There is also the fact that electricity is the power source activating all the world's communications equipment. Consequently buzzwords have become jargon, jargon-words have been 'buzzed,' and a wide variety of people - having no connection with electrical technology in general - thrust words, expressions and initials into reports, discussions and daily speech whose meaning they but dimly perceive. A few examples will illustrate what I mean.

Initials

'You can't get it? What are you on then, AM or FM?' a friend or colleague enquires, thereby translating two specific modulation techniques into station or waveband identification symbols. And this without - in many cases - the person in question having any idea as to what the initials stand for.

Another brace of initials which have also become meaningless buzzwords to many people are UHF and VHF. Here too, particularly where Television (TV) is concerned, they have long become different in meaning to what they actually stand for, namely Ultra High Frequency and Very High Frequency respectively. Indeed TV is as loaded with jargon and buzzwords as any other aspect of electronics.

The Colour TV broadcasting technique used throughout most of Europe for example, is the German/British Phase Alternate Line, or PAL, system. Britain contributed considerably to the system specification and the equipment was manufactured initially by Telefunken. Both countries began broadcasting with this system in 1967. France however decided to develop its own method of colour TV broadcasting, the *Séquentiel Couleur à Memoire,* or SECAM, system. This technique is also used in Russia, which remains the only other European country to have adopted it besides France.

There is, of course, an irony in all this, for both systems are developments of the American National Television Systems Committee (NTSC) method. This technique used a dot sequential system with a shadow-mask tube and two image signals to give the earliest, successful, TV colour broadcasting system.

The three techniques remain rivals throughout the globe, their initials batted about in much the same way as many other sets of much misunderstood initials and abbreviations.

Video recording is another area where initials are commonplace without, it seems, those who use them most frequently having any idea as to what they stand for. The earliest form of this type of technology was the professional machines produced by Ampex in the 1950s. Twenty years later however, both the Sony and Matsushita corporations developed their Betamax and Video Home System, or VHS, recording techniques. Although both systems employ 13-mm tape, they are incompatible!

'What's the problem? It's nothing a DIN plug can't sort out.' Yet another familiar set of initials are aired in the course of a conversation on - say - the problems of interconnecting some new High Fidelity (Hi-Fi) equipment someone has just bought. Does the questioner know what DIN stands for or, that he is - strictly speaking - using an incorrect abbreviation? Indeed, he may even be unaware that we're talking DIN **plugs plural,** as illustrated in Figure one.

Probably not, for in most such conversations the name of the game is being at ease with techno-speak. In other words being able to use buzzwords or jargon to impress those who are uncomfortable with technology in any form. DIN - or more properly DIA - is the abbreviation for *Deutsche Industrienormen Ausschuss,* or the 'German Standards-making Authority.' DIN simply cuts out the Ausschuss part of the description.

Another set of initials all too frequently quoted in specifications and elsewhere is DIL. This abbreviation stands for *Dual in Line,* and applies to the standard layout for Integrated Circuit (IC) packaging, using two parallel rows of connecting pins along each side of the package.

So it continues, with Private Mobile Radio (PMR), Digital Radio Broadcasting (DRB), Cellular Mobile Radio (CMR), and a number of other sets of initials frequently bandied about in job advertisements, news items and public relations puffs, confusing even people already in the industry.

Digital itself is another word from our respective fields which is - either as it stands, or in its abbreviated form of *digi* - rapidly become a buzzword's buzzword, without first of all having become jargon!

Jargon Becomes Catch Phrase

There are some buzzwords or jargon expressions that are used daily, to the extent that they've become Catch phrases. One such expression is 'at this moment in time,' used when - in reality - the speaker simply means 'now.' Another example of this status seeking is *Input* and *Output.*

The Dictionary of Communications Technology gives five distinct-function entries

for each of these words. Do people who use expressions such as '. . your input is being processed as an important part of the whole, Tom,' imagine that - by doing so - they will be thought more technologically knowledgeable?

I ask, because such expressions are almost always part of the *argot* of the technologically challenged, in the same way that 'at this moment in time,' has become the 'in' phrase of the wordy. Incidentally, *argot* is a nineteenth century French word of unknown origin which means slang. It denoted the jargon of one group in particular - thieves!

Another 'in' catch phrase - now hopelessly overworked in the media generally - is *High Tech*, short for High Technology. Anyone offering such a solution to a particular problem was obviously proposing using the most up to date technology. This - to many people - hinted at ideas, devices and techniques from aviation, electronics or some other 'leading edge' technology such as space flight.

The reality of course was frequently very different, particularly in areas such as interior design where, at one time, virtually every new office was a High Tech design!

Low Tech of course meant exactly that: a solution which appeared disgracefully sluggish and ill-willed, totally at variance with its counterpart above. Yet many so-called *High Tech* solutions turned out to be less than environmentally friendly, a fact soon realised by the *Low Tech* advocates. *Low Tech* shortly realised that it was by no means finished and - renaming itself Alternative Technology - has more than held its own.

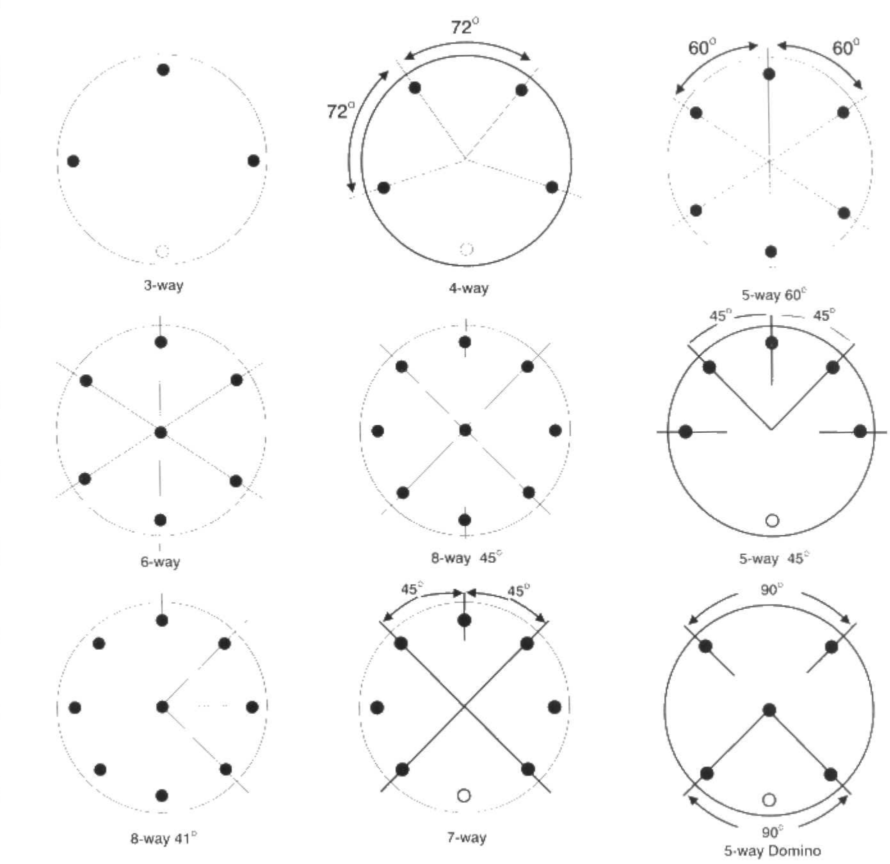


Figure 1: DIN Audio Connectors, created by the German Industrial Standards Board.

Acronyms

When it comes to acronyms however, even more confusion sets in. Everyone, even the most technically ignorant layman, knows what *Radar* is. It's that piece of kit that keeps aircraft apart both in the sky and on the runway at Heathrow and elsewhere. Yes: that's one way of looking at it. However, how many people, even in the industry, are aware that radar is one of the very few disciplines whose name is an acronym?

When the British began developing an air defence aid using radio waves in the mid-1930s, they gave it the rather lengthy title of **Rad**io Location **A**nd **R**anging. The Americans found this too much of a mouthful and promptly created the acronym from the original title. Radar it has remained ever since.

More recently, another acronym entered the language and rapidly spread throughout the world. Today, in the fiftieth year of its invention, few people indeed have not heard of the Transistor. Yet even fewer know that - like radar before it - it too is an acronym.

It is a combination of *trans*, from 'transfer' and *istor* from 'resistor.' It was suggested to the design team by a colleague who - on learning that the tiny device still had no name - said that he understood that their invention transferred current across a resistance. Why not therefore create a name of some sort from this fact?

Acronyms such as *Avionics and Mechatronics* however are really examples of our old friend the Coinage. *Avi* is the first three letters of Aviation whilst *onics* is the last five letters of Electronics. Therefore an *Avionics* engineer - or technical author for that matter - is someone involved in the electronics of aviation.

Mechatronics is a coinage from Mechanics and Electronics, yet another illustration of how widespread and influential electronics has become. Nowhere is this more obvious than in computers, where buzzwords and jargon abound, in fact have almost reached the status of a separate language. We'll take a look at this constantly developing milieu next month.

Electronics in AGRICULTURE

PART 9

Crop Spraying

In this final part George Pickworth discusses orchard sprayers, remote sensors & calibration.

Photo 20. A radial type mist blower (photo courtesy of Hardi Sprayers Ltd.)

While arable crop protection was relegated to traditional crop rotations during the period that British agriculture was in the doldrums, fruit growers had no alternative other than to continue with spraying if the trees were to be maintained in a productive state.

Orchard spraying had traditionally been a manual operation but in 1943, when labour shortage was hampering efforts to maximize war time fruit production, Pest Control Ltd. (PCL) developed an automatic orchard spraying machine of Figure 16.

Although somewhat primitive, the automatic sprayers were very effective. Indeed, by bringing about an improvement in orchard pest control and production of home grown fruit, these sprayers made a real contribution towards maintaining the health of the nation during the dark days of World War II.

During the post war years, the demand for high quality produce, made possible by the development of more efficient agrochemicals, brought about the development of the highly sophisticated sprayers used today. Photos 20 and 21. Moreover, as we will see the new agrochemicals and sprayers revolutionized orchard management in the UK

Traditional

As already mentioned, orchards were sprayed by workers wielding hand-lance type nozzles connected to the spraying machine by length of high pressure hose. The sprayer pump was powered by a small engine and the complete unit was towed in stages by a horse between the rows of trees.

Later, the horse was replaced by a tractor which also powered the sprayer pump; this allowed more powerful pumps to be used and as a result, a much greater discharge rate from the hand lances. Spraying could therefore proceed at a faster rate.

At that time, apples, plums and indeed most fruit trees were sprayed during the winter months with either a tar oil emulsion or a light mineral oil emulsion containing DNOC. The objective was to kill pest eggs before they had a chance to hatch in the spring.

However, because of the minimal surface area presented by the dormant trees, wastage of spray fluid was enormous and much rained back onto the operators. So, notwithstanding "waterproof" clothing, the operators were invariably soaked with tar oil or stained yellow with DNOC.

Following the development of the automatic sprayer it was logical for PCL to initiate contact orchard spraying service. Indeed, fruit growers were only too pleased to hand the cold, wet and very unpleasant work of winter orchard spraying to a contractor. The basis of the 1943 automatic sprayers was the 500 gallon 'Bean' sprayers. See Photo 2 in part 6. The spray booms were removed during October, when crop spraying had ended for the season and replaced with the orchard spraying gear; this consisted of a number of nozzles attached to a rocker assembly. The rocking movement simulated the action of an operator using a hand lance. See Figure 16

Complete Coverage

To be effective, the whole of the dormant trees had to be literally drenched with spray. Otherwise, some pest eggs escaped the spray. The spray fluid was therefore applied with high pressure jets at operating at pressures of 70 bars or even more. The nozzles were virtually the same as those used for fire fighting, indeed these were the only kind of nozzle able to project a drenching spray to the tops of tall trees. Fluid application rates were therefore very high and ranged from 2,000l/ha for small trees to 10,000l/ha for large trees. But as with hand spraying, wastage of spray was considerable.

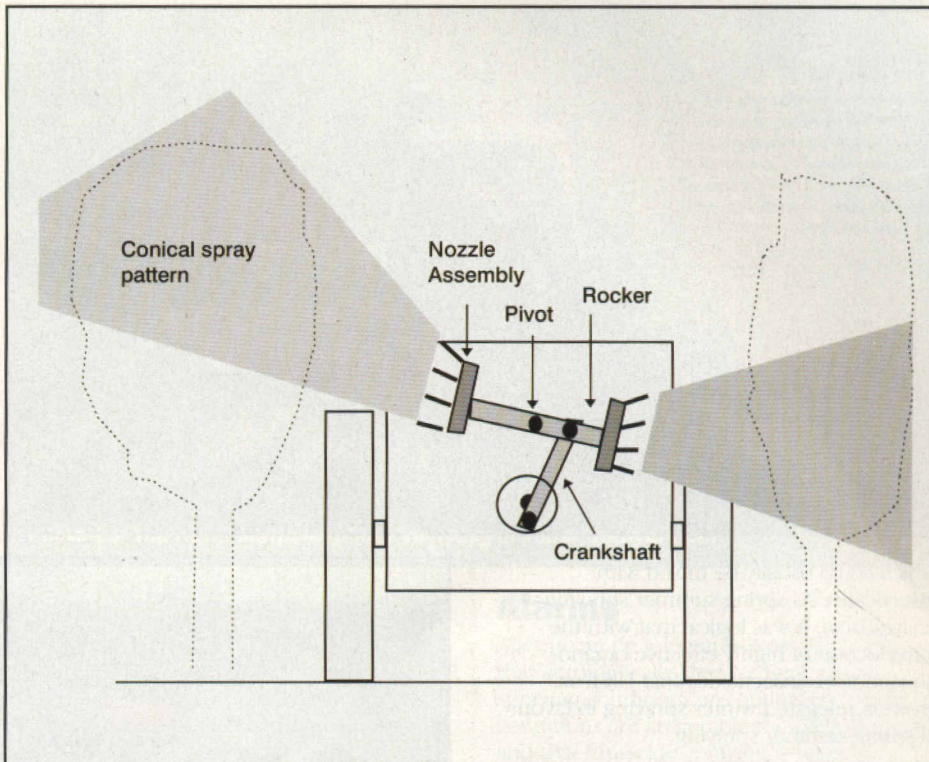


Figure 16. Sketch of PCL's 1943 high volume orchard sprayer - compare with Photo 20 & 21. The crank was attached to the end of the agitator drive shaft.

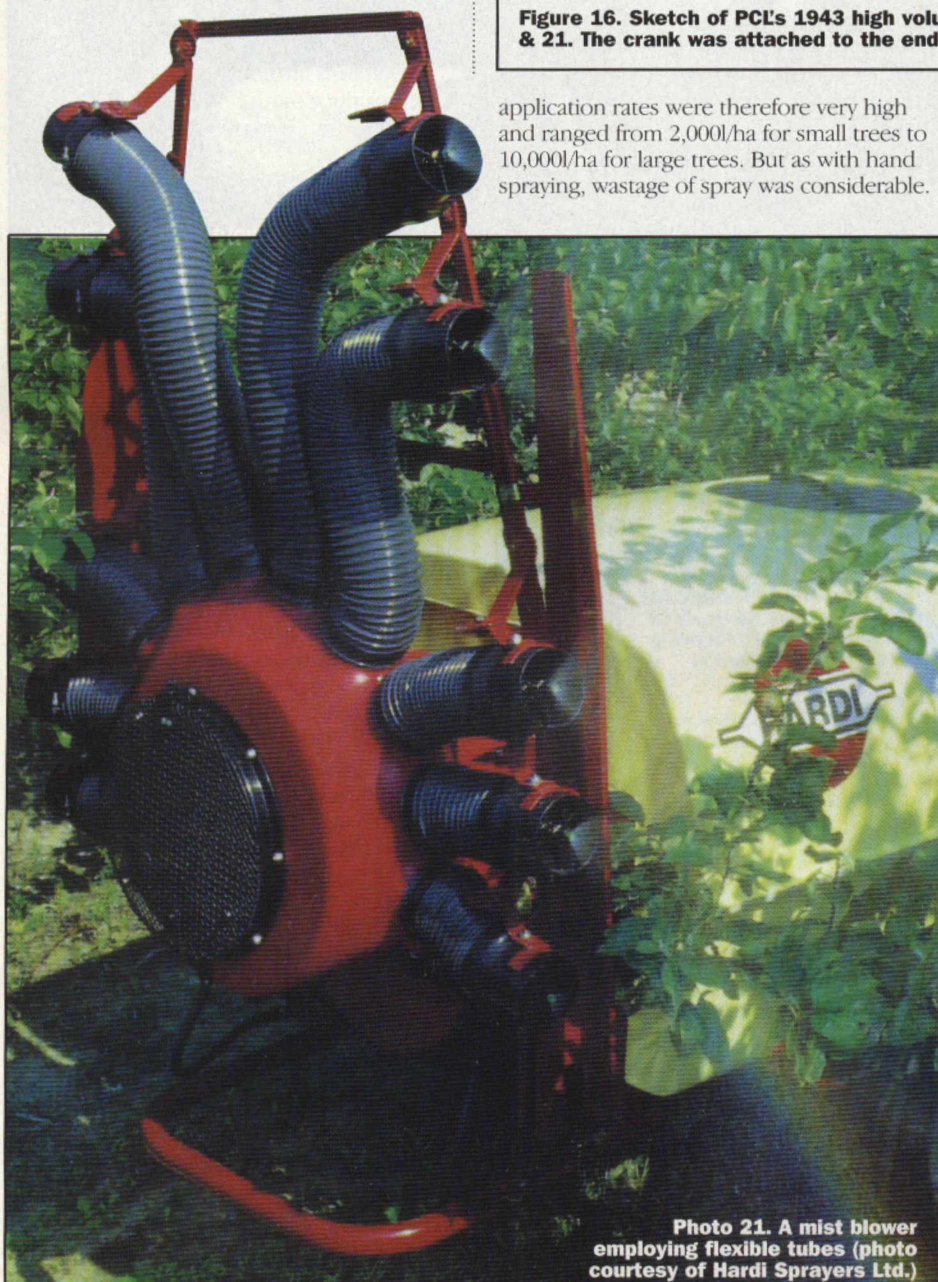


Photo 21. A mist blower employing flexible tubes (photo courtesy of Hardi Sprayers Ltd.)

Demise Of Winter Spraying

Unfortunately, even after the best endeavors, winter spraying was only partially effective and invariably needed to be followed up with several insecticide sprays during spring and summer.

Originally, spring and summer was also done manually, but some chemicals, for example lead arsenate was highly toxic whilst lime-sulphur was foul smelling. The later organo-phosphourous sprays were extremely toxic. So, it was not surprising that automatic sprayers were soon in demand for spring and summer spraying work. The problem was that during the latter war years and immediate post war years, spraying machines were in very short supply and during spring and summer the "Bean" sprayers were desperately required for weed and pest control in field crops. So, until about 1947, when more machines became available, some spring and summer orchard spraying had to remain a manual operation.

America

The Americans never had much interest winter spraying and preferred to concentrate control measures on the actual pests by applying insecticides when the pests were active and the trees in leaf.

Unlike the winter sprays, spring/summer sprays could be effectively applied as very small droplets or as a mist. So, even before WW2, the Americans had developed air blast sprayers which projected very small droplets or mist into the tree foliage. As with field crop sprayers, the use of very small droplets required a much reduced volume of spray. Moreover, the air blast ruffled the leaves and thereby enhanced spray coverage. Furthermore, air-blast sprayers were well adapted to application of fungicide sprays

Photo 22. Similar to Photo 21 but has flexible tubes arranged for treating crops in rows. Note tractor has air-filtered cab (photo courtesy of Hardi Sprayers Ltd.)

which could usually be mixed with insecticides. As spring/summer spraying was unavoidable, it was logical that with the introduction of highly effective organo-phosphorous insecticides that UK fruit growers relegated winter spraying in favour of spring/summer spraying.

Photo 23. A mist blower employing a single flexible tube for treating low growth fruit bushes (photo courtesy of Hardi Sprayers Ltd.)

American

The sprayer shown in Photo 20 has its roots in early American mist sprayers. Fluid is supplied at a pressure in the order of 40 bars to a number of nozzles attached to a ring at the rear of the sprayer. A large blower, delivering typically 300m³/min, directs a blast of air radially over the nozzles thus projecting the mist into the trees. Moreover, by adjusting the volume of air and the deflectors, a good measure of control can be achieved over the

Photo 24. A tractor mounted mist blower. Note driver is wearing full protective clothing (photo courtesy of Hardi Sprayers Ltd.)

distribution mist. So, droplet size can be as low as 100μm. This would be out of the question under open field conditions.

An alternative approach is to feed fluid at a pressure in the order of 20 bars to nozzles installed in the ends of large diameter flexible tubes. The air blast from each tube, typically 200m³/min, projects the spray mist into the tree foliage. The tubes can be adjusted individually so that the spray can be directed to specific parts of the trees. See Photo 21.

Fluid application rate depends to some extent upon the characteristics of the spray chemical and pests present but with medium size trees application rate is typically in the order of 300l/ha. Compare this with 2,000l/ha with early high volume sprayers.

The flexible tube method can be employed to direct the spray to crops in rows thus increasing the versatility of this type of machine as shown in Photo 22. An alternative to the multi tube system is to employ a single large diameter tube with multiple nozzles attached to its end; this method is well adapted to treating a wide swath of low growing trees or bushes. See Photo 23.

The electronics employed with orchard sprayers are similar to, though less sophisticated to those used with field crop sprayers; the reason being that once the sprayer is manually set up for a particular orchard, changes to the sprayer characteristics during operation are generally unnecessary. See photo 25.

Hazards

A feature of mist-blower type sprayers is that the air blast directs the mist away from the driver. Nonetheless, the driver must be properly protected, ideally by the tractor having an air filtered cab, Photo 22. However, cabs are precluded in orchards where branches hang low, so here the driver has to wear full protective clothing. See Photo 24 and 21a.

Obviously it would be desirable to eliminate the driver and this was the great attraction of the 1960's Massey Ferguson driverless tractor (*Electronics and Beyond* issue 125, May 98, page30) But despite the hazards and wearing of full protective clothing, drivers remain the preferred option.

The drawback to the Massey Ferguson system was that a guidance wire had to be laid underground between the rows of trees. However, following advances in optical recognition systems the guidance wire can be eliminated. The Silsoe autonomous vehicle (*Electronics and Beyond* issue 126 June 98 page 24) may well be the precursor of orchard sprayers of the future.

Photo 25. Display panel of an orchard sprayer (photo courtesy of Hardi Sprayers Ltd.)

Timing

Biologically, there is an optimum time for applying agrochemicals, be it a field crop an orchard. For example, application rates of selective herbicides can be dramatically reduced by spraying when the weeds are at an early stage of development. See Figure 17. But weeds quickly grow and the optimum spraying time may last for only a few days, but, spraying is only possible when soil and climatic conditions are favourable and these may only last for a few hours.

Much the same applies to insect pests, so ideally, insecticides should be applied during the initial stages of infestation and before significant damage is done to the crop. However, some pests, particularly aphids, multiply at a phenomenal rate.

Fungicides are generally applied immediately climatic conditions become favourable for the development of fungus diseases; the fungicide is therefore applied as a preventative measure.

It would be wasteful to apply a spray if conditions favourable for fungus diseases did not occur. Conversely, if spray is not applied, and the disease gets a hold, control measures become much more difficult. Timing of spraying is therefore critical.

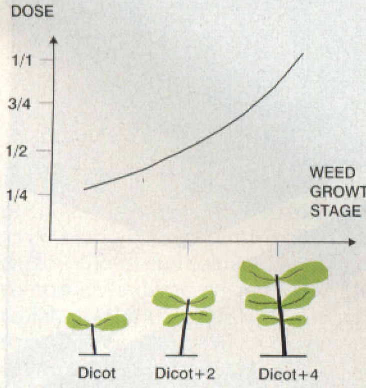
So, to be able to complete spraying within a very short time slot, spraying machines have become larger and more sophisticated. Photos 13, 14, 16 & 17 part 8.

Climatic Conditions

Modern agrochemicals are somewhat less weather sensitive than earlier products, nonetheless rain must not have recently fallen or be imminent. Wind speed must not exceed 10m/sec and ideally be not more than 4.5m/sec. Moreover, the soil must be reasonably dry and firm enough to bear the weight of the sprayer.

Furthermore, as we have seen, modern sprayers allow the spraying time slot to be somewhat widened. For example, air assisted sprayers enable spraying to continue when winds would have precluded spraying with earlier machines. Moreover, low ground pressure tyres enable spraying to continue when sprayers with conventional tyres would sink into the soil.

Figure 17. Graph showing theoretical relationship between weed growth stage and dosage requirement.



Theoretical relationship between growth stage of the weed and what dose is necessary to control the weed. The same kind of relationship is valid for most pests and diseases

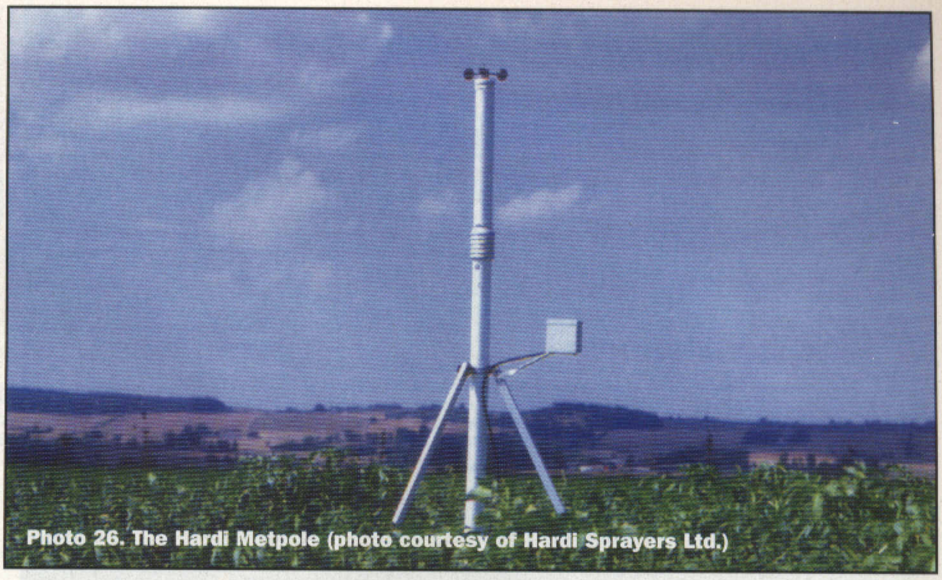


Photo 26. The Hardi Metpole (photo courtesy of Hardi Sprayers Ltd.)

Remote Sensors

Whilst conditions may have seemed favourable for spraying when perceived from the farm office, the only way to determine if actual field conditions were suitable was to make frequent inspections of the fields. Nowadays, farmers can install sensors in the fields which transmit the relevant data by radio to the farm office computer. The HARDI METPOLE™ for example, (Photo 26) has six or twelve sensors, depending on model; it stores and transmits data on field conditions to the farm office every 30 minutes. Data includes wind speed, surface wetness, global radiation, air temperature, air humidity, soil temperature, soil water and rainfall.

Moreover, one receiver/computer is able to store and process data from up to 20 Metpoles; this can be complemented by data provided by the various meteorological advisory services.

The farm office PC runs a programme which is a model designed to forecast weather and the incidence of crop diseases. The computer continually updates data received from the sensors and presents information to the farmer by a specially developed Windows programme. See Photo 27.

Alarms

Alarms can be integrated with the system that automatically alert farmers when spraying conditions are optimum or that conditions are favourable for plant diseases and that fungicide spraying is urgent. Information can also be transmitted to mobile phones equipped to display text under the small messages service (SMS). The information presented by remote sensors can be applied to virtually every cultural operation ranging from ploughing/sowing the crop and ultimately informing the farmer that conditions are suitable for combine harvesting. The system can also be used to advise fruit growers that frosts are imminent and that frost protection measures must be implemented.

Global Positioning Systems (GPS)

GPS in agriculture was described in Electronics and Beyond issue No 122 Feb. 98 page 13. However, for completeness the following notes are included in this study. Weeds or pests usually vary in density across the field. So by employing the GPS keeps track of the sprayer, its on-board computer

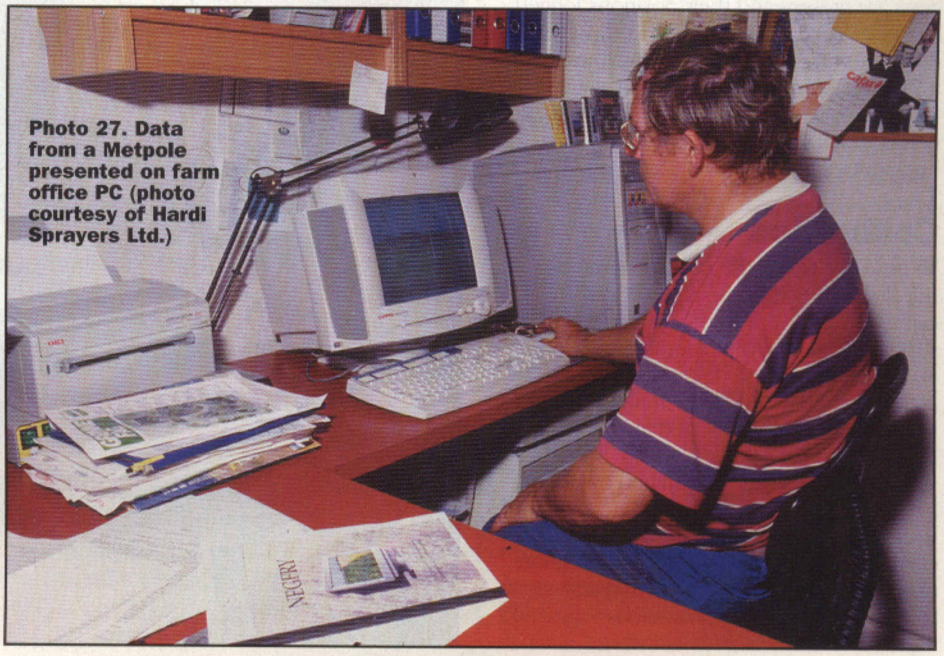


Photo 27. Data from a Metpole presented on farm office PC (photo courtesy of Hardi Sprayers Ltd.)

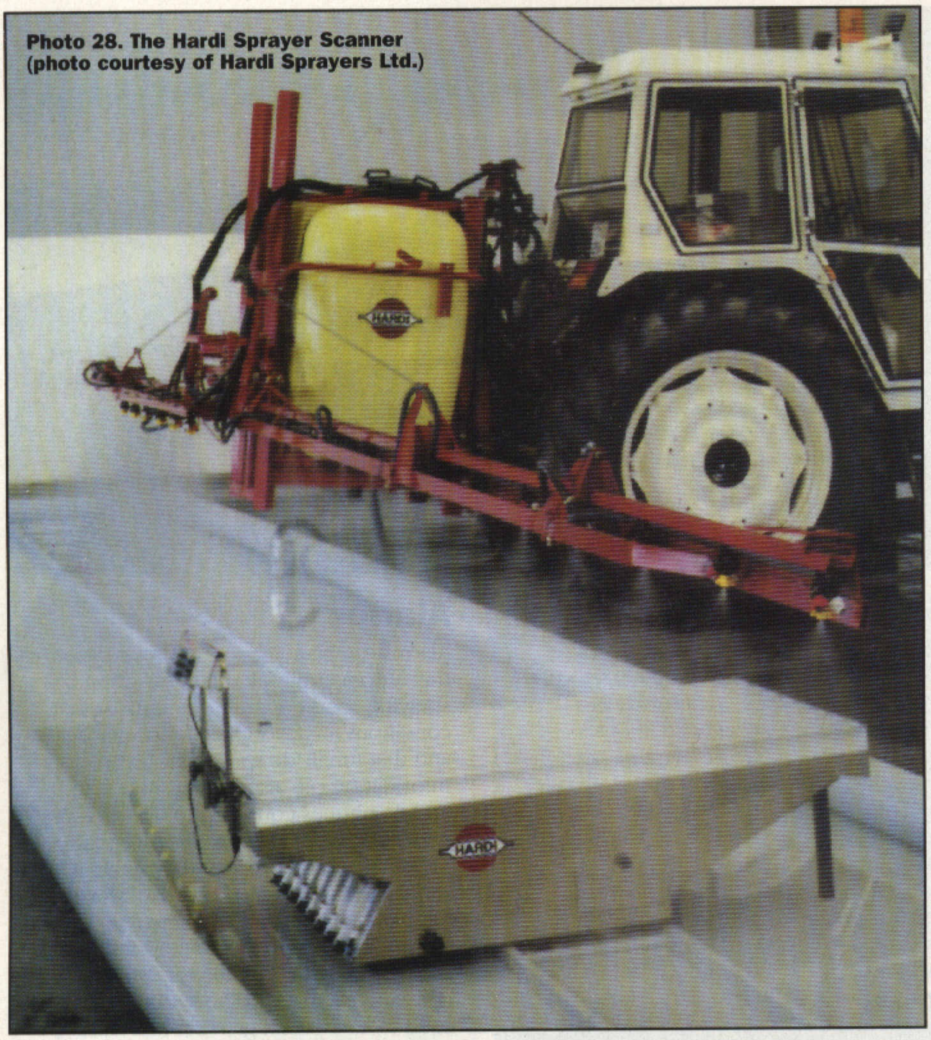


Photo 28. The Hardi Sprayer Scanner (photo courtesy of Hardi Sprayers Ltd.)

can be programmed to tell the sprayer to apply chemicals at specific dose rates on various parts of the field.

The on-board computer/GPS seems well adapted for use with new generation sprayers under development where individual chemicals are diluted with water in the actual nozzles rather than in the sprayer tank as with conventional sprayers. The new technology will enable specific spray mixtures to be applied to various parts of the field.

Obviously, the field has to be first inspected to determine which weeds or pests are present and their positions logged by means of hand held GPS; this is normally during routine field inspections, typically on a Quad ATV. However, much information is usually already on hand from field maps prepared during previous cultural operations with machines fitted with GPS.

Calibration

To ensure efficient use of agrochemicals, the sprayer needs to be periodically calibrated. So, prior to the development of sophisticated electronic devices, the only way to measure fluid discharge rates was to place a container under each nozzle and measure the liquid collected after a given length of time.

Spray pattern was determined by placing a number of containers on the ground and measuring the relative volumes of fluid in each container. These primitive calibration methods can still give important information, but are now being superseded by sophisticated electronic scanners.

The HARDI SPRAY SCANNER™ is a sophisticated test module that measures and calculates all key nozzle parameters, including discharge rate and spray pattern, under actual field conditions. The actual module is mounted on a trolley that moves on rails under the length of the sprayer boom; it is therefore easily set up in the field (see Photo 28).

The module consists of 8-open channels which collect spray fluid; the volume is measured consecutively as the trolley moves in stages along the length of the boom. Data is directly presented on a LCD screen but this can be transferred to the office PC for a more detailed display or printout of the measured values and graphs (Photo 29).

Droplet Measurements

In my young days, droplets size was determined by using a microscope to measure the diameter of a crater formed by droplets impacting a film of magnesium oxide on a glass plate. Nowadays, sophisticated radar systems are use; however, this is beyond scope of this study.

Conclusion

Meanwhile, I hope that these studies have given readers a better understanding of modern farming methods and perhaps motivate some readers to consider agricultural engineering as a profession. Indeed, agricultural technology, particularly with regard to electronics, is advancing at a rapid pace.

Appreciation

Thanks go to:-
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and Paul Miller, Silsoe Research Institute,
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I also wish to thank:-
Ted Southcombe of AgEvo for providing the rare black and white archive photographs.

Finally, I wish to thank:- Bernard Tebbutt, crop spraying pioneer and contractor who helped with technical details of early spraying machines. ELECTRONICS

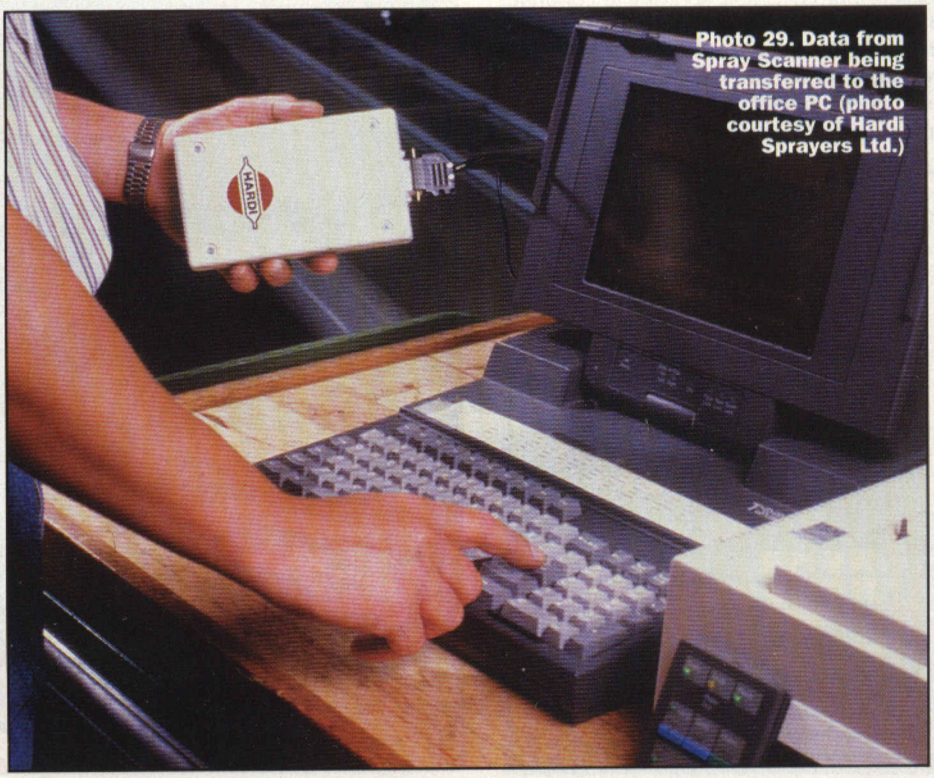


Photo 29. Data from Spray Scanner being transferred to the office PC (photo courtesy of Hardi Sprayers Ltd.)

COMMENT

by Keith Brindley

Is the world of the Internet about to be turned upside-down? Possibly not, but the recent news that America Online (known as AOL to UK users) is to purchase Netscape Communications makes me wonder. This was rapidly followed by the news that America Online was to enter into a strategic partnership with Sun Microsystems, and suddenly the whole thing seems to fall into context like an assistant referee's flag.

Officially, America Online's acquisition of Netscape Communications in combination with the alliance with Sun Microsystems is to strengthen AOL's multiple brand strategy, broaden its audience, and take e-commerce to a new level. That's an interesting PR concept if you can get your teeth round it, but it boils down to two things. First, America Online wants to expand its network to get new customers for its AOL service. Second, it sees e-commerce (the ability to buys things over the Internet) as an important requirement.

This is good news for Netscape Communications stockholders. The stock-for-stock, pooling-of-interests transaction, in which stockholders of Netscape will receive 0.45 shares of AOL common stock for each share of Netscape common stock, is valued at $4.2 billion. It is expected to be completed this spring, but is subject to various conditions including customary regulatory approvals and approval by Netscape's shareholders. Netscape's operations are to remain at its home base in Mountain View, California.

This is also good news for Sun Microsystems stockholders as increased use of Sun Microsystems products worldwide will see increased turnovers and hopefully increased profits. Officially, the reason for the America Online/Sun Microsystems venture is to accelerate the growth of e-commerce, and to use Sun's Java technology to develop selected next-generation Internet devices that will help Internet users access America Online brands from anywhere, anytime. Again, this PR-speak could mean just about anything, but gleaning the relevant information from the news release, it's just possible to see that they will work together to develop a comprehensive suite of easy-to-deploy, end-to-end solutions to help companies and Internet service providers rapidly enter the e-commerce market and scale their e-commerce operations.

The deal cuts both ways. Sun will become a lead systems and service provider to America Online, and America Online commits itself to purchase systems and services worth $500 million at list price from Sun through to the year 2002 for its e-commerce partners and its own use. Meanwhile, America Online will receive more than $350 million in licensing, marketing and advertising fees from Sun, plus significant minimum revenue commitments, over the next three years.

The benefits of America Online' alliance with Sun Microsystems and purchase of Netscape Communications is fairly clear. America Online will be able to provide for its millions of customers a means whereby they can sell products over the Internet, and most important, they can do this in a standardised and reliable manner. While e-commerce already exists it's done in an unstandardised manner to date, which while not necessarily unreliable, requires significant setting up, monitoring and maintenance.

Steve Case, Chairman and Chief Executive Officer of America Online, gave a significant quote as the two deals were announced: "By acquiring Netscape and working with Sun to provide winning e-commerce solutions, we will be able to both broaden - and deepen our relationships with business partners who need this additional level of infrastructure support, and to provide more value and convenience for Internet consumers. We share with Sun a vision for the future in which consumers will be able to access America Online brands anywhere, at any time, and from any device, and we believe that with this alliance, we can make this happen more quickly."

Effectively, the purchase and the deal will take advantage of the complementary strengths of America Online, Sun and Netscape. These include America Online's success as an Internet service provider, Sun Microsystems expertise and global reach as a software and network computing provider, and Netscape's suite of e-commerce software and services. Together, the companies will be able to offer complete solutions, along with software and consulting services, to enable businesses to go online quickly and allowing them to scale rapidly to meet consumer demand.

Once setup, America Online customers will be able to completely outsource their electronic commerce operations, with America Online providing everything from Internet traffic and application connectivity to online marketing, orders, billing and payments. Sun and America Online will also market their e-commerce solutions to non-America Online users including, of course, other Internet service providers who want to create part of the solution themselves. The products will be available on Sun's Solaris operating environment as well as on other operating systems.

This is quite an achievement by America Online, and one which deserves deeper consideration. America Online currently has some 14,000,000 members worldwide, and it owns CompuServe which in turn has some 2,000,000 members worldwide. As a result, America Online owns and maintains a rather huge chunk of the Internet and its users. If it also sells this e-commerce solution to other Internet service providers then there's a chance that the majority of the Internet will do electronic business the America Online/Sun Microsystems way.

Also, interestingly, it sets America Online head-to-head with its main competitor in all of this – Microsoft. It's no secret that America Online and Microsoft merely suffer each other. America Online licenses Microsoft Internet Explorer and uses it in its current client software that all of its 14,000,000 members use. CompuServe also uses Microsoft Internet Explorer in its client software. Yet, Microsoft runs the Microsoft Network (msn) which competes directly with AOL. Microsoft also likes to think of itself as a major player in the e-commerce world. Sun Microsystems has a known hatred of Microsoft as a result of its legal battle with Microsoft over Sun Microsystems – Java programming language and Microsoft's cavalier attitude to it is documented elsewhere in this issue (see @Internet). Netscape Communication's Web browser was once the most popular Web browser around, but it's now threatened by Microsoft Internet Explorer. Interestingly, the US Department of Justice legal battle with Microsoft (the boys in Seattle – get themselves into the courtroom a lot don't they?) is over alleged uncompetitive practices by Microsoft to have its Web browser defeat Netscape's Navigator.

Over the last few years things have been playing into Microsoft's hands, and its game has been rather one-sided. But the referee finally seems to have blown the whistle for offside. America Online's purchase of Netscape and parallel deal with Sun Microsystems, coupled with Sun Microsystems and the US Department of Justice legal actions, may do nothing else than level the playing field which Microsoft currently controls. Maybe there will a satisfactory result at full-time, after all. ELECTRONICS

The opinions expressed by the author are not necessarily those of the publisher or the editor.

ECLIPSED

Keith Brindley throws some light on the astronomical event of the year. Mark 11 August in your diary, and make sure you have a good line of sight.

It's not something that happens all that often, and it's such a spectacular event when it does happen, that a total solar eclipse viewed from anywhere on earth is a sight to behold. When one happens in Britain on the other hand – and one is scheduled to take place later this year – it makes such an important incident that the eyes of the astronomical world will be upon us. Not just astronomers will be interested though as a total solar eclipse is such an awe-inspiring event that few people can possibly remain unmoved.

In truth, the total eclipse will only be visible in the farthest south-western area of the British Isles that is Cornwall and south Devon, although the Scilly Isles and Alderney are also in the area where the eclipse will be total. That doesn't mean to say that other areas of the British Isles won't be able to soak up the sun (or its absence, anyway), because even in the farthest north-east, the Orkneys say, something like a 70% eclipse will be viewable. So you don't need to head down to the south-west for the duration if you don't want as it's going to be a spectacular occasion for us all. This is perhaps just as well, because the south-west is expecting a tourist invasion for 11th August as a direct result of the eclipse, the likes of which it has never experienced before.

What is an eclipse?

Technically, an eclipse occurs when light from one celestial object is temporarily cut off from a second, by the presence of a third. In the case of our own solar system this typically occurs when either earth gets between the sun and the moon (called a lunar eclipse), or when the moon gets between the sun and earth – a solar eclipse. In effect, when the moon gets between the sun and earth a shadow is formed – just like the shadows you see on a sunny day – and it's this shadow on earth's surface that marks the boundaries where the eclipse is viewable. Outside the edges of this shadow the eclipse is not complete, and it's known as a partial eclipse. But in the centre of the shadow the moon blocks out the sun's light completely, and the eclipse is said to be total. As the earth and the moon are both constantly moving relative to the sun, the shadow formed moves around earth's surface in a strip. At its centre, where the eclipse is total, known as the eclipse totality, this strip shadow is only around 50 miles wide. However, the complete eclipse strip is a few hundred miles wide, although only a partial eclipse is viewable for that region.

That's why only the south-westernmost part of the British Isles will have a total eclipse on 11th August this year, and why the rest of the British Isles will experience an eclipse ranging from upwards of 70% or so. The further north you are, the lower the percentage of eclipse. Nevertheless, the whole of Britain will be gloriously bathed in darkness, of varying amounts.

How does it happen?

Earth orbits round the sun in an imaginary plane called the ecliptic. The moon, on the other hand, orbits in another plane round earth, tilted at a slight incline from the ecliptic by around 5°. As a result, during each lunar orbit, the moon passes through the ecliptic twice – at points which are technically known as nodes (although sometimes they are called equinoxes). For total eclipses to occur certain criteria have to be fulfilled. First, the moon must be at a node. Second, sun, moon, and earth must be aligned along the imaginary line that joins the two lunar nodes. When these criteria are met, a total eclipse occurs.

How do we predict eclipses?

Eclipse predictions can be calculated quite simply, because we know how eclipses are formed. Starting from any given eclipse – which can only occur when sun, moon, and earth are aligned along the ecliptic node line – then it is a matter of calculating when they next return to the same relative position. The period, called the saros (meaning key), corresponds to 19 returns of the sun to the same node, 242 returns of the moon, and 223 lunar months, and is 18 years, 9 to 11 days (depending on the number of leap years during the period), and eight hours long. This periodicity means that any pattern of eclipses occurring during the saros will be repeated, but because of the partial day (that is, the eight hours) the repetition of eclipses is displaced by around 120° around earth's surface, so the eclipses forming the saros pattern do not occur at the same places on earth each time. Interestingly, it was the Babylonians who first calculated the saros periodicity.

While, for those areas in the eclipse totality area, total eclipse will last only a minute or two (actually, just over two minutes for those places in the centre of the eclipse totality area), for all of Britain the period before and after totality will be marked by gradually increasing then decreasing amounts of eclipse, so that the whole event will take something like two-and-a-half hours from its start through to its conclusion. At around ten o'clock on the morning of 11th August, the eclipse will start as the moon starts to take a chunk out of the sun. Over the next 75 minutes this chunk will get larger and larger until the moon covers the sun to its maximum.

In the eclipse totality area, brilliant points of light may be seen flashing out in crescent shapes as the final crescent of light fades. These are called Bailey's beads, and are caused by sunlight shining along valleys and irregularities on the very edge of the moon. Following this, the sun will now be totally 'out' and it will be dark – at least, it will in the area of eclipse totality – with a light level something around the intensity of bright moonlight. This will be at approximately 11.12am in south-west England. Eerily, the stars will come out, birds will stop singing and other creatures will go quiet. You'll probably notice a coolness to the air, and a chilly wind may form in the rapidly cooled atmosphere. It will feel decidedly peculiar.

Looking back towards the sun, you'll be able to see its corona, or atmosphere. This will look like a ring of white lights streaking out from the sun's surface out into space. If we're very lucky gas eruptions from the sun's surface, known as prominences, may be visible as red clouds around the eclipse outsides. Sometimes during eclipses narrow bands of moving shadows can be seen, caused by irregular refraction of sunlight as it passes through earth's atmosphere.

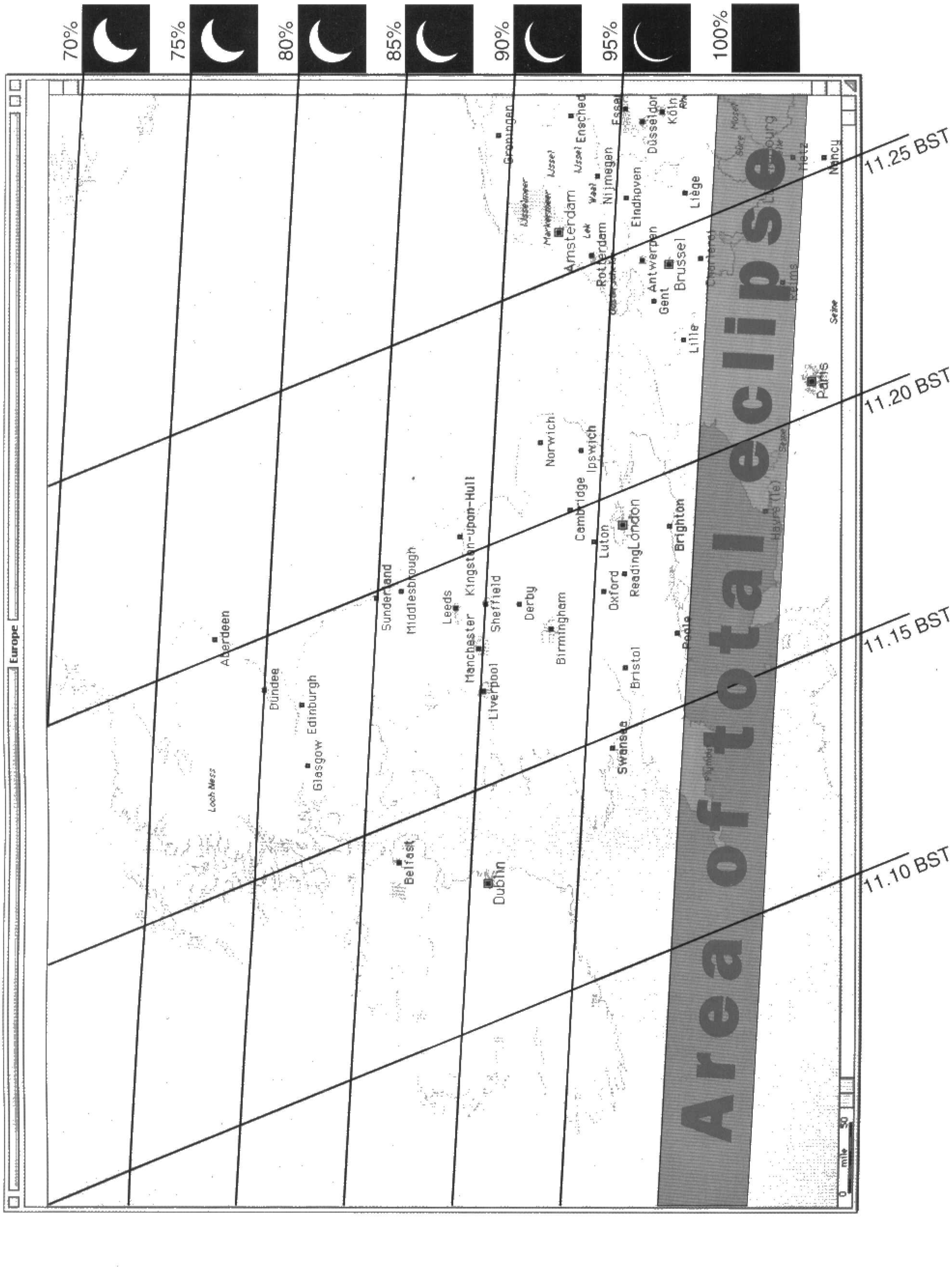
No more two minutes later, though, totality will be over. There'll be some more Bailey's beads at that instant, then the sun will start to become visible again as an increasingly larger crescent of light, the reverse of how it disappeared. For the next 75 minutes or so the crescent will get bigger and bigger until at last, some two-and-a-half hours after starting, the eclipse itself will all be over.

Ahh never mind, we only have to wait 92 years for the next one!

Interesting facts

You'll need special dark lenses or glasses to view the eclipse. Don't under any circumstances attempt to view it without these, as damage to eyes occur by direct exposure to sunlight. Special glasses made of aluminised mylar are already available for the event and, if you haven't found any yet, expect them to become popular leading up to the eclipse. Finally, make sure the lenses are not damaged in any way, as surface scratches could theoretically allow dangerous light levels to pass through

The sun is roughly 400 times wider than the moon. Coincidentally, the sun is also around 400 times further away from earth than the sun. As a result the moon and the



Pinpoint your location on the morning of 11th August 1998. Estimate along the vertical axis the percentage of totality the eclipse will take at your position. Estimate the time maximum eclipse occurs at your position along the bottom axis.

sun appear roughly the same size when viewed from the earth, and it's this fact that makes a total solar eclipse what it is – when the moon gets between the sun and earth it almost exactly covers the sun when viewed along the centre of the line so formed

If earth's orbit around the sun (the ecliptic) was in the same plane as the moon's orbit around earth, then sun, moon and earth would be in alignment along the two nodes twice each lunar orbit, therefore there would be two total eclipses every lunar orbit (that is, a lunar eclipse every full moon, and a solar eclipse every new moon). However, the inclination at around 5° between the lunar orbital plane and the ecliptic means this is not the case

By the millennium, some 228 solar eclipses and 147 lunar eclipses will have occurred during the 20th century

The last total eclipse viewed in mainland Britain was on 29 June 1927. The next will be on 23 September 2090. That's why it's important to make sure you see it

Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

February 1999

25 February Smartcard, Olympia, London. Tel: (01895) 454545.

March 1999

10 to 11 March Softworld Accounting and Finance, Interactive Information Services, Grand Hall, Olympia, London. Tel: (0181) 541 5040.

19 March Windows 1999 Show, Olympia, London. Tel: (01256) 381456.

24 to 25 March Softworld for the Supply Chain, NEC, Birmingham. Tel: (0181) 541 5040.

31 Mar to 1 April Conference on Antennas and Propagation, IEE, University of York. Tel: (0171) 240 1871.

April 1999

3 to 18 April Edinburgh International Science Festival, Ediburgh. Tel: (0131) 220 6220.

13 to 15 April NEPCON Electronics, NEC, Birmingham. Tel: (0181) 910 7910.

20 to 21 April Intranet EXPO 1999, Earl's Court, London. Tel: (0181) 742 2828.

May 1999

17 to 19 May Cable & Satellite Mediacast 1999, Earl's Court, London. Tel: (0181) 910 7931.

25 to 27 May Internet World UK Spring 1999, Earl's Court, London. Tel: 0171 976 0405.

25 to 28 May Ninth International Conference on Metering and Tariffs for Energy Supply International, IEE, Conference Centre, Birmingham. Tel: (0171) 240 1871.

26 to 27 May Embedded Systems, Olympia, London. Tel: (0171) 681 1000.

June 1999

7 to 11 June 16th International Teletraffic Congress, IEE, Edinburgh International Conference Centre. Tel: (0171) 240 1871.

21 to 23 June People in Control an International Conference on Human Interfaces in Control Rooms, Cockpits and Command Centres, IEE, University of Bath. Tel: (0171) 240 1871.

12 to 15 June Seventh International Conference on Image Processing and its Applications, Manchester. Tel: (0171) 240 1871.

29 June to 1 July NETWORKS Telecom, NEC, Birmingham. Tel: (0181) 742 2828.

July 1999

26 to 28 July Third International Conference on Advanced A/D and D/A Conversion Techniques and their Applications, University of Strathclyde, Glasgow. Tel: (0171) 240 1871.

August 1999

23 to 27 August Eleventh International Symposium on High-Voltage Engineering, London. Tel: (0171) 240 1871.

September 1999

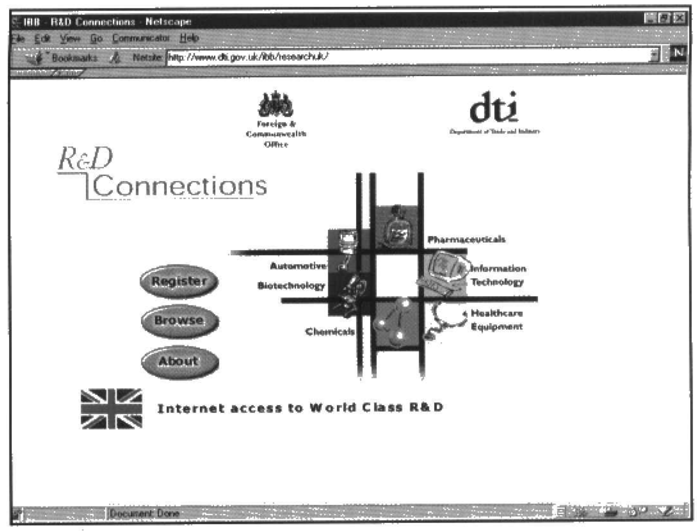
1 to 3 September Ninth International Conference on Electrical Machines and Drives, Canterbury Christ Church College. Tel: (0171) 240 1871.

7 to 10 September Ninth International Conference on Artificial Neural Networks, IEE Conference on Artificial Neural Networks, University of Edinburgh. Tel: (0171) 240 1871.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Mandelson Calls on Business to Take Scientific Approach



A revolution in the approach of business to Britain's world class science and engineering base was called for this month by Peter Mandelson, Secretary of State for Trade and Industry.

Exploitation of knowledge held the key to reversing a century of industrial decline. Speaking at a joint Invest in Britain Bureau/ Foresight programme seminar, Mandelson said, "The 21st century is going to be dominated by knowledge. To revolutionise our industrial performance, catch up and overtake our competitors we must make more of the unique resource that is our science and engineering base.

"Today with 1% of the world's population the UK produces around 6% of its science. It would be a tragedy to waste this national treasure. That is why the Government announced in July that with the Wellcome Trust we would be investing an extra £1.4bn in the science base. This will mean new laboratories, equipment and research in areas vital to compete in the Knowledge Driven Economy."

Making the most of British scientific know-how would be done through partnership, education and a revolution in business culture. Mandelson, continued, "Partnerships are the name of the game. It is one of Britain's great economic strengths, it has attracted the world's leading companies to this country, and it is the key to long- term prosperity in the years ahead.

"Encouraging co-operation between business and the science base is at the heart of the Government's Foresight programme. Through Foresight people from business, academia, government and the voluntary sector are brought together to pursue shared goals. The power of Foresight is shown by the fact that for every £1 invested it is estimated that a member company gains access to £40 of high quality research."

This investment needed to be matched to a society equipped for the information age, he said, "Our £19 billion investment in education is one of the largest by any government anywhere in the world. 'Open for Learning, Open for Business'. I could not think of a more suitable summary of this Government's approach to the knowledge driven economy of the future."

Forging a culture of enterprise and risk-taking was at the heart of turning our knowledge into commercial gain, he said, "I want to foster a real climate of enterprise in the UK. We need a culture that rewards risk, does not unduly penalise failure and above all lauds ambition.

"In his pre-Budget Report, the Chancellor, outlined a number of new measures to support enterprise. My forthcoming White Paper will take the story on, setting out a range of policies to encourage business to become truly innovative and enterprising.

"To raise productivity in this country we must learn from the best practice of the international companies this country has an unrivalled record in attracting."

Concluding, Mandelson said, "My philosophy is simple – to put the future on Britain's side. To provide the business environment within which business can compete and win in world markets. Exploiting our scientific and engineering base will be a key part of placing this country in the vanguard of the knowledge-driven revolution."

The seminar was attended by Lord Sainsbury, Minister for Science, together with leading figures from the business, research and academic communities.

A new Web site at **<www.dti.gov.uk/ibb/researchuk>** entitled R&D Connections was launched at the seminar and will provide a forum for bringing together companies and UK researchers. Listing UK centres of research excellence with details of their areas of expertise, it allows interested companies to search for information or potential research partners.

Swatch Launches Internet Time

Swatch has blown away the concept of time zones with the whole new concept of measuring time in the future: Swatch Internet Time. Presented in Cambridge this week to the more than 90 kids from 54 countries participating in the Junior Summit at MIT's Media Lab, Swatch Internet Time is global time for a Cyberworld.

"Cyberspace has no seasons and no night and day," Nicholas Negroponte, founder and director of the Media Lab said, in introducing Swatch Internet Time at the Junior Summit. "Internet Time is absolute time for everybody. Internet Time is not geopolitical. It is global. In the future, for many people, real time will be Internet Time."

Swatch Internet Time represents a completely new global concept where there are no time zones – no geographical borders to time. Swatch has divided up the virtual and real day into 1,000 beats. Each Swatch Beat is equivalent to 1 minute 26.4 seconds. Swatch also created a new meridian for Internet Time at the Swatch headquarters in Biel, Switzerland. Biel Mean Time (BMT) is the universal reference for Internet Time.

How does Internet Time work? A day in Internet Time begins @ 000 Swatch Beats – or midnight BMT (Central Europe Time). That means that 12 noon in the old system is the equivalent of @500 Swatch Beats.

For the participants at the Junior Summit who come from virtually every time zone in the world, Internet Time simplifies the process of scheduling on-line chats once they return to their homes. For new friends from China, India or the U.S., Internet Time is the same for everyone. Confused about calculating Internet Time? Just check the Swatch Web site at **<www.swatch.com>** or the CNN Web site at **<www.cnn.com>**. In addition to posting the Swatch Internet Time, both Web sites also provide a list of cities worldwide with the corresponding Internet Time posted for each.

Beginning after the first of the year, Swatch will make keeping up with Internet Time even easier with the introduction of its first digital watch, Swatch Beat. The first models of the Swatch Beat watch available anywhere in the world were presented to the Junior Summit participants to use during the week of meetings and project development at the Media Lab. The young leaders not only incorporated the Internet Time concept into their scheduling for the week, they used their watches and Internet Time to launch their own discussions regarding new ways of thinking about time in the new millennium.

In addition to Internet Time, the bold new watch offers functions that display local time, time in another time zone, a fixed countdown to the Y2K (Year 2000), a timer, a stop function and an alarm.

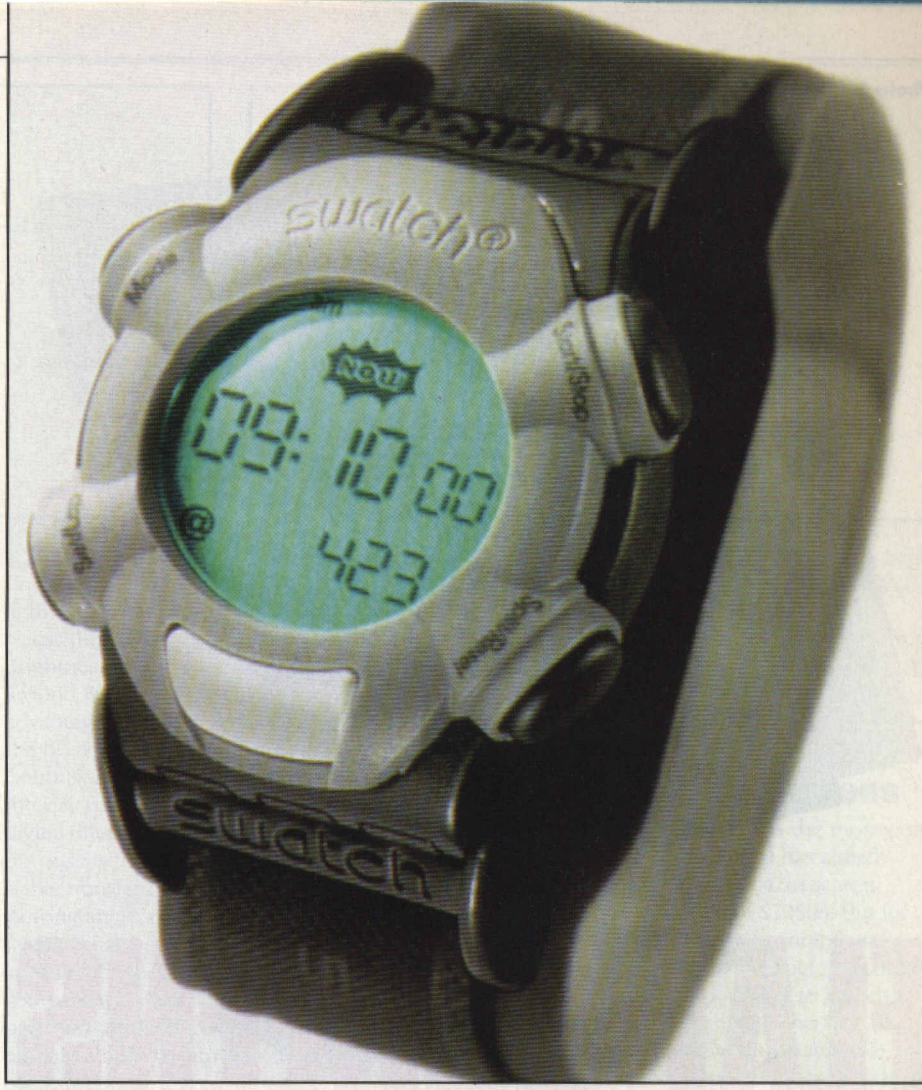


Photo 1. LG LCD monitor.

FLAT SCREENS

Reg Miles looks at the latest developments in flat screen technology.

After a tenuous start flat screens are finding markets as their prices decrease and their performance increases. With companies now putting a lot of resources into expediting those positive factors.

Desktop Computer Monitors

One growth area is the flat desktop computer monitor. These, normally LCD, screens have the advantage of a fixed geometry (thus no distortion), no focusing errors, no screen radiation, complete immunity to magnetic fields, low heat generation, and low power consumption. They are also light weight and take up little desk space. The disadvantages are that the reproduction quality still cannot match the CRT standard – although it is getting ever closer, and it is comparatively expensive – the new 15in model from LG, for example, is about £1000 including VAT. An even more rapid growth area is the notebook computer – all with LCD screens. Which are getting larger all the time – 12 and 13 inch are now commonplace. With colour having completely replaced the grey-scale option.

But the most noticeable inroads by LCD screens are the small ones on camcorders and digital still cameras. Ranging from under two inches to over four inches. Sharp has recently launched a camcorder with a touch-sensitive screen, allowing instant zooming, focus setting and limited area backlight compensation.

In a basic twisted nematic (TN) display the liquid crystal material is contained between two glass substrates with a spacing of about 5μm. The molecules are twisted into a 90° helix at rest, and light that has passed through a polarising filter is directed by the molecules through a second polarising filter perpendicular to the first. Applying a voltage through transparent electrodes causes the molecules to line up and provide a straight path for the light which is then blocked by the second polarising filter.

In a practical device the screen is a dot matrix; with each dot formed where transparent row and column electrodes cross and control the light in the aforementioned manner (Figure 1). This is a passive matrix display; with the drive structure and circuitry shown in Figure 2. Compare this with the active matrix drive (Figure 3), with thin film transistors (TFT) attached to each pixel to control their switching. The switching signals are applied to the X electrodes and image signals to the Y electrodes. Each pixel forms a capacitor attached to the drain of the TFT, and when that is switched on it applies a voltage across the single capacitor. The voltage level of the signal determines the degree to which the liquid crystal molecules twist and thus the quantity of light transmitted. Colour is achieved by covering each individual dot with a red, green or blue filter to form a pixel triplet.

Different passive matrix types have been developed because with TN (Figure 4a) the contrast drops as the screen size increases (though it is ideal for active matrix TFT).

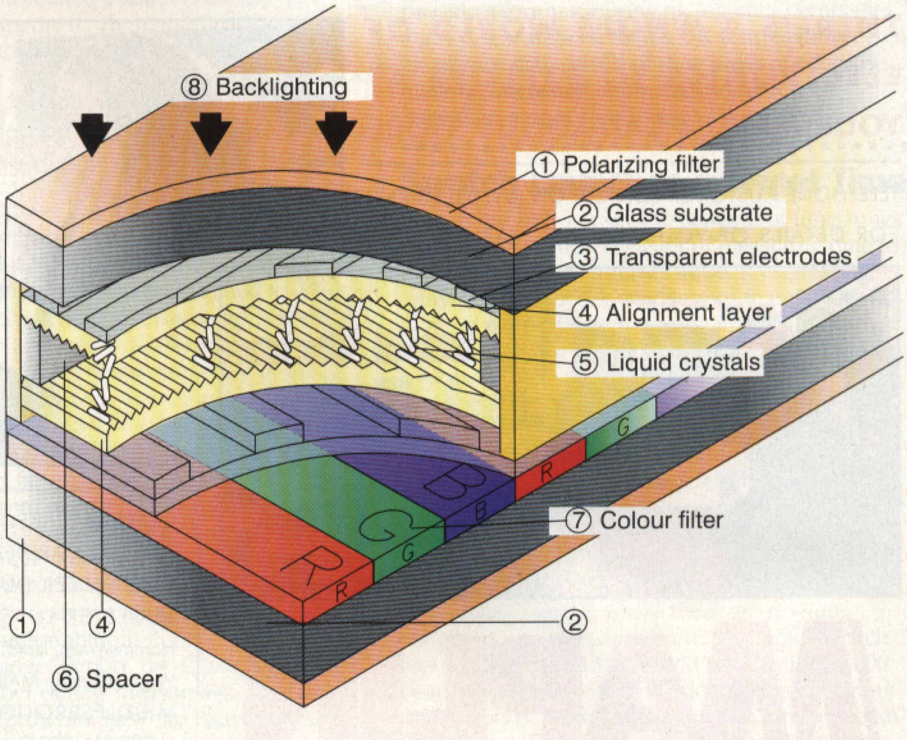


Figure 1. LCD Structire.

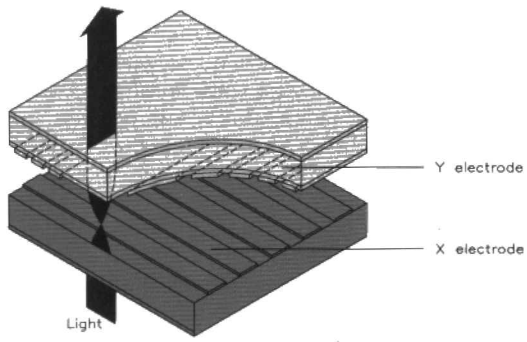


Figure 2a. Passive matrix drive.

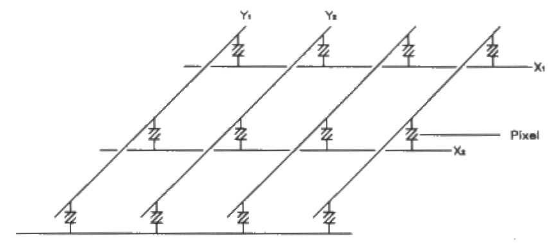


Figure 2b. Passive matrix circuitry.

The types generally used for notebook computers are super twisted nematic (STN) and double super twisted nematic (DSTN). The former adds an extra twist that increases contrast (Figure 4b); while the latter adds a second LC layer, or cell, that compensates for the twist in the operating layer to give a B&W shutter function for greater contrast (Figure 4c). The more expensive models use TN TFT. As do all monitors, as well as movie and still cameras. It gives better colour, contrast and dynamic range, and has the fast response essential for full motion video.

An increasing number of companies are producing both passive matrix and TFT LCDs, including Citizen, Hitachi, IBM, Mitsubishi, Philips, Sanyo, Sharp and Toshiba. And are working to improve their performance.

Latest Improvements

Recent developments have replaced the amorphous silicon TFTs with poly-silicon ones – which has improved reliability and reduced production costs. Furthermore, efforts are now being concentrated on three areas: brightness, contrast and viewing angle (which have all been rather poor).

Brightness has been a problem because only part of each individual dot can pass light: in a normal screen the aperture ratio is less than 50%, whereas in the latest high-brightness panels this has been increased to around 80%. This has the additional advantages of increasing contrast because the black looks blacker by comparison. Contrast is further enhanced by the use of the low voltage differential signalling (LVDS) digital interface; although its primary purpose is to minimise interference for the stable transfer of image data. Widening the viewing angle, particularly in the vertical where it has been most limited, can be achieved by the use of birefringent compensation foils, manufactured by the polymerisation of reactive LC molecules, that partially undo the unwanted birefringent effect of the LC layer; or by various changes to the construction of the LC layer itself.

A particularly radical change is to replace the filters by inorganic RGB phosphors used in combination with a UV light source – increasing both the brightness and the viewing angle. Or the use of dichroic fluorescence to convert UV light into visible polarised light, instead of a conventional polariser that absorbs light.

Although LCD is not associated with large screens, Sharp has demonstrated 28in VGA and 40in SVGA TFT models. Both are constructed from two smaller panels with a seamless join. And have a dot pitch of 0.88 x 0.88mm and 1.0 x 1.0mm respectively. Their external thicknesses are just 37mm and 50mm.

Large Plasma Screens

But it is plasma that now has the monopoly on large flat screens. Philips has already launched in the UK a 16:9 42in screen, 115mm thick at a price of £12500. But for this you get 100Hz digital scanning and a 120W 13 speaker Dolby ProLogic Surround system. Panasonic is planning to launch a 16:9 42in model here at the end of 1998. Although there are few details available, and no price, which also applies to the JVC 16:9 42in model, which is planned for a beginning of '99 launch. Incidentally, Panasonic's parent company, Matsushita, was the first to develop both 26in and 40in models in 1995, working within the Japanese 'Hi-Vision Plasma Display Panel Consortium', formed with the intention of having large, high-definition wall-mounted screens in time to show the 1998 Nagano Winter Olympic Games.

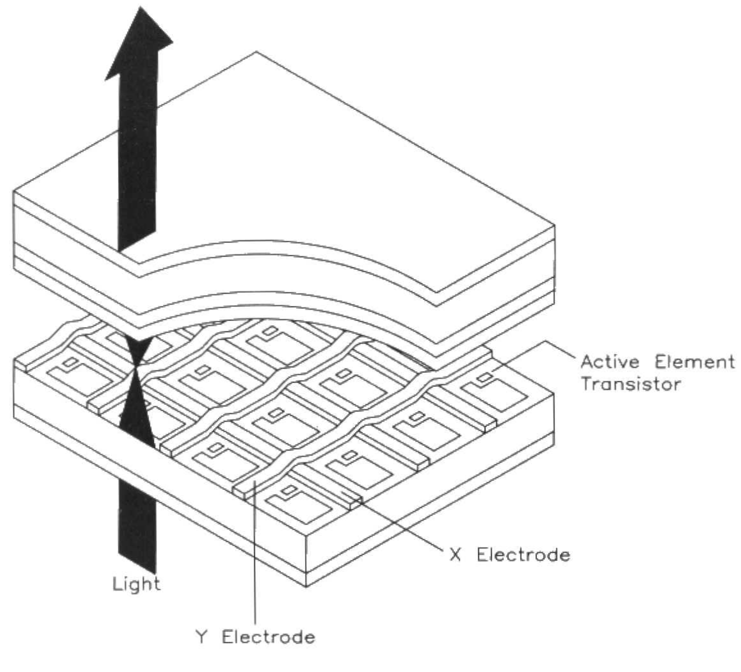


Figure 3. Active matrix drive.

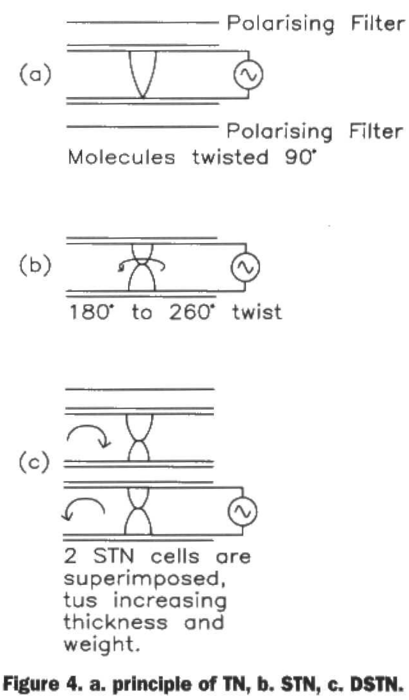


Figure 4. a. principle of TN, b. STN, c. DSTN.

Photo 2. Panasonic laptop DVDPro non-linear editor with LCD screens.

Things are also starting to move on the business/professional side. Hitachi has an XGA compatible 40in model with 1024x768 pixels (and is planning consumer models of 40in and larger). JVC Professional has a 16:9 42in screen; with a 400:1 contrast ratio that is equal to any display device. EIKI's latest 16:9 42in model also has a 400:1 contrast ratio. And Sony is on the verge of launching a 16:9 42in model.

Plasma screens have similar advantages to LCD screens, but do tend to have a rather high power consumption of between 200-400W. But they do have their own advantages to offset this power consumption – the internal generation of light, so no backlighting; an intrinsically wider viewing angle – of about 160°; and greater brightness and contrast.

The plasma screen consists of front and rear glass plates partitioned to form a mosaic of tiny cells filled with gas (Figure 5a). The inner surface of the front glass is coated with a dielectric layer containing a pair of display electrodes, behind which is a protective layer of magnesium oxide. Between the ribs are cells consisting of red, green and blue phosphors with embedded addressing electrodes, each containing a low pressure mixture of neon and xenon gas – the three RGB cells forming one enclosed pixel. When several hundred volts is applied between the electrodes the surface electrical discharge on the protective layer turns the gas into a plasma which produces UV light that excites the individual phosphors (Figure 5b). Because the intensity of the discharge cannot be varied to produce the necessary grey scale levels, pulse width modulation is used to vary the number of discharges each time the image is refreshed to give the illusion of intensity variations (discharges can be stopped and started within one-millionth of a second). With the normal 8-bit addressing there are 1-8 discharges, giving 256 greyscale levels and the famous 16.77 million colours.

Because the market is miniscule at present, and likely to remain that way for some years to come, the screens are all constructed for the American and Japanese markets, and for use as both computer or multimedia and video display monitors. Thus, they have 480 lines; suiting the VGA and NTSC standards (IBM created the VGA standard to be used on NTSC monitors with 480 active lines). For PAL or SECAM the 575 active lines have to be converted digitally to fit in. Being widescreen the number of

Photo 3. Sharp touchscreen ViewCam.

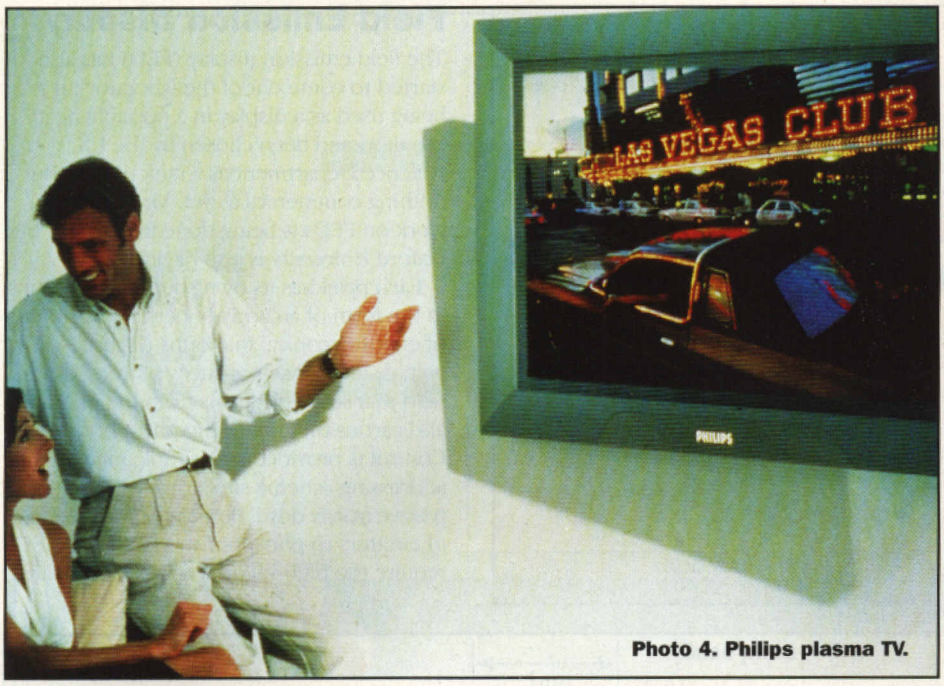


Photo 4. Philips plasma TV.

horizontal pixels is 852 so they have the usual range of widescreen TV facilities for fitting in the different aspect ratios, plus the possibly, of allowing compressed SVGA to be shown. Smaller screen sizes from 21in have been produced, both 16:9 and 4:3; and it is expected that eventually sizes will range from 20-50in.

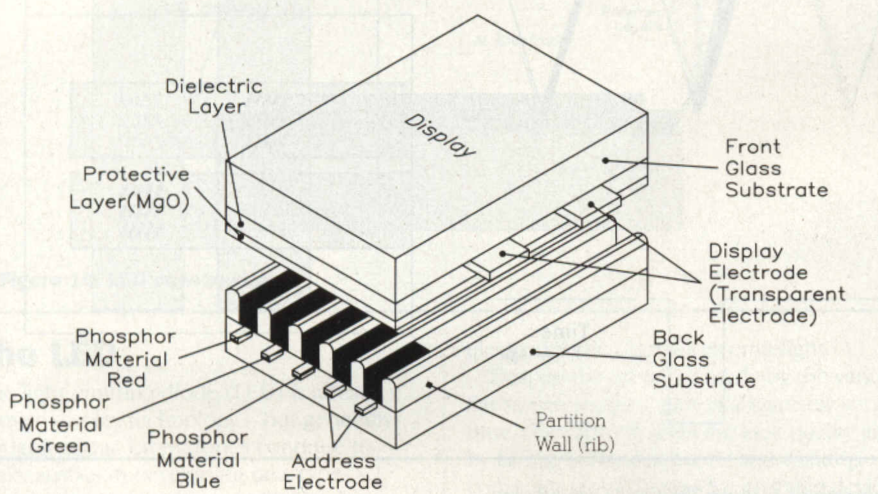


Figure 5a. Plasma structure.

Plasma Addressed Liquid Crystal

A still more recent technology is a combination of plasma and liquid crystal, known as plasma addressed liquid crystal (PALC). Here, the plasma discharges are not used to make phosphors glow but to act as electronic switches, obviating the need for transistors, and so reducing the cost of this active matrix system. The underlying PALC technology was originally invented by Tektronix; in 1992 Sony became interested and the two companies began jointly developing it. In 1996 they were joined by Sharp, and in 1997 by Philips. Different screen sizes have been shown; and this October at the Japan Electronics Show '98 they showed the first 16:9 42in high definition TV (HDTV). This has 1920 pixels horizontally (each consisting of three RGB dots) and 960 lines, with a dot pitch of 0.162 x 0.546mm. They also showed an enhanced VGA version – also 16:9 42in.

The plasma section is behind the LC layer (Figure 6). The section is divided into horizontal channels containing the gas (each equivalent to one scanning line). When it discharges it provides a conductive channel acting as a common address electrode for all the LC pixels in one line, enabling them to be switched and receive a complete line of image signals using the column and anode electrodes. With a normal backlight, the result combines high brightness, reasonable contrast, and a good viewing angle.

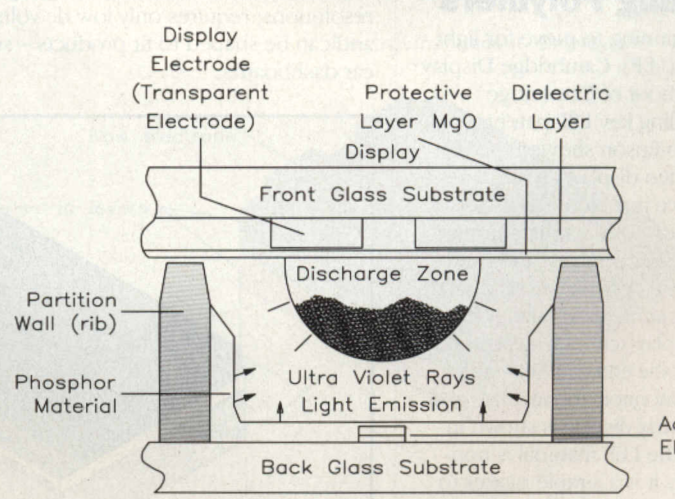


Figure 5b. Plasma operation.

Ferroelectric LCD

Another variation on LCD is ferroelectric LCD (FLCD). In this type the LC molecules have a permanent dipole with two stable undriven states, and the crossed (or parallel) polarisers are aligned along one of the stable directions. The long molecules are in smectic phase and tilted in the layer. A voltage pulse of one polarity rotates the molecules, where they remain until a pulse of opposite polarity returns them to their original position (Figure 7). The image is therefore retained with the power off. This non-volatile memory also allows the number of scanning lines to be increased without sacrificing contrast. Which is intrinsically higher than conventional LCD anyway. FLCD also has a faster response rate and a wider viewing angle. Additionally, it requires only a passive matrix drive.

But, despite its promise, Canon has the only commercially available FLCD backlit colour display – a 15in computer monitor. A number of other companies have been working on it, including in the UK Thorn's Central Research Laboratories (formerly EMI Laboratories) who have licenced the technology to a number of companies. But progress has been slower than many had anticipated a few years ago. Now a working relationship has started between Sharp's Functional Device Laboratory in Japan, Sharp's UK research laboratories and the

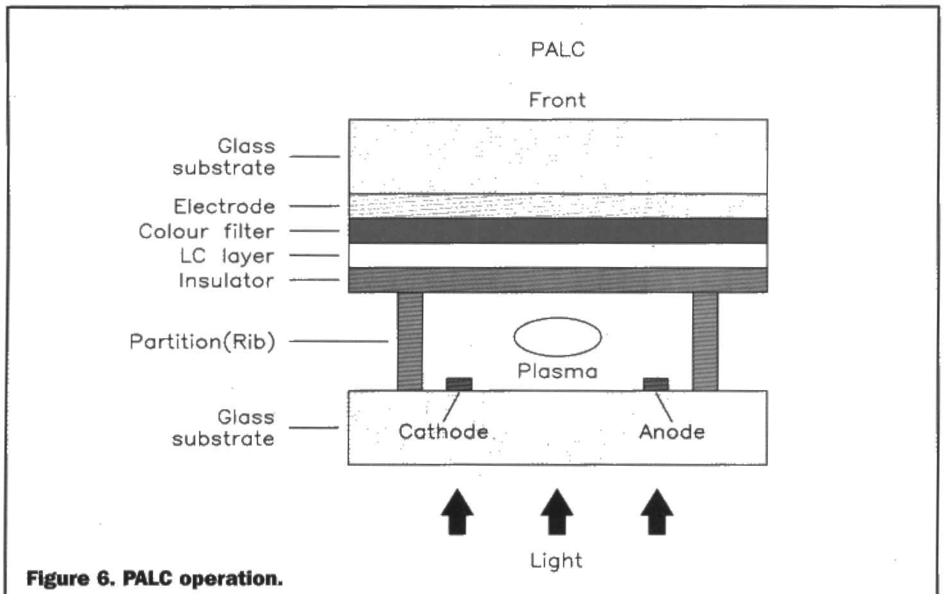


Figure 6. PALC operation.

Field Emission Display

The field emission display (FED) has also started to come out of the laboratory. It is being used as a display in a portable heart monitor; and been chosen by the US Defence Department as a tank display. But nothing commercial as yet. Virtually all the work on FEDs is being done in the USA, but Oxford University is also having a go.

Each pixel has its own source of electrons in the form of an array of perhaps hundreds of emitting conical microtips (Figure 9). The voltage difference produces a strong electric field that strips electrons from the microtips and carries them onto the phosphor screen. Control is provided by a simple matrix addressing scheme similar to the LCD passive matrix drive. Because of the proximity of emitters to phosphor the FED does not require the high vacuum of a CRT, allowing a thinner and lighter faceplate. Diamond emitters have come back into favour again, after some early difficulties with the diamond/graphite composite films, because the display performance is better and fabrication simpler than FEDs using molybdenum or silicon.

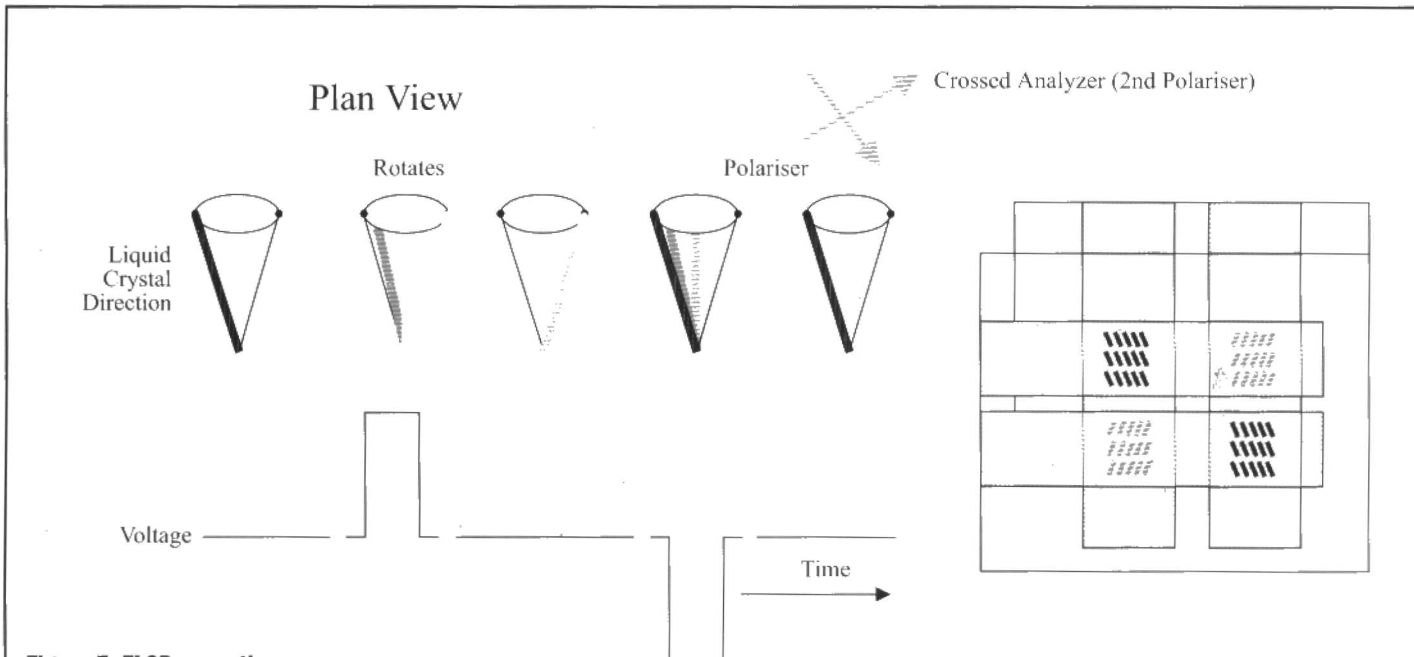


Figure 7. FLCD operation.

UK's Defence Evaluation Research Agency (DERA) to pool knowledge and attempt to overcome the difficulties.

Light Emitting Polymers

Things are also beginning to move for light emitting polymers (LEP). Cambridge Display Technology, an offshoot of Cambridge University and holding key LEP patents, together with Seiko-Epson showed the world's first LEP video display – a 2in monochrome device just 2mm thick. Seiko-Epson are known for both manufacturing LCD screens and inkjet printers; and used the latter to print the polymer pixels directly onto a TFT active matrix backplane. A full size colour LEP display screen is expected to be demonstrated at the end of 1998 – with TVs and computer monitors the ultimate goal.

A passive dot-matrix display is shown in Figure 8. Because the LEP material is non-conducting laterally it is a simple matter to print or coat the two polymer layers forming the p-n junction equivalent. The pixels are formed where the Aluminium and transparent Indium Tin Oxide electrodes cross, with the brightness varied by altering the current. No backlight is required, or colour filters; it has a 180 degree viewing angle; the potential for achieving high resolutions; requires only low dc voltages; and can be shaped to fit products – such as car dashboards.

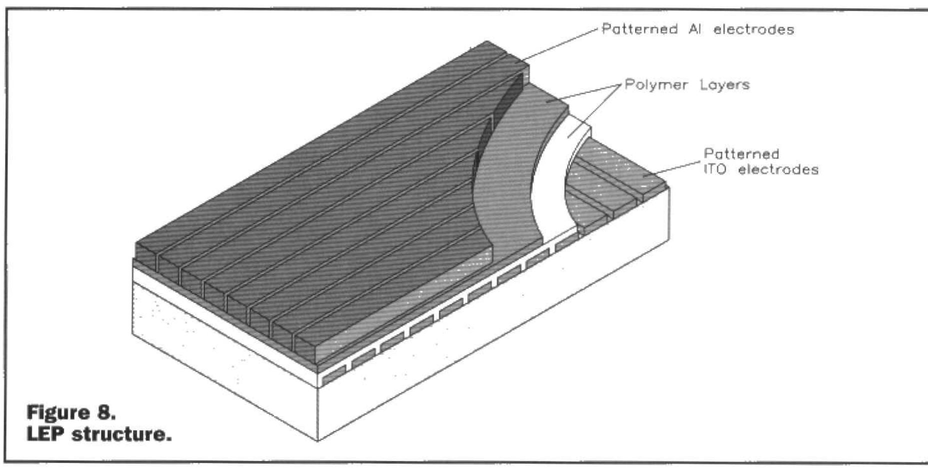


Figure 8. LEP structure.

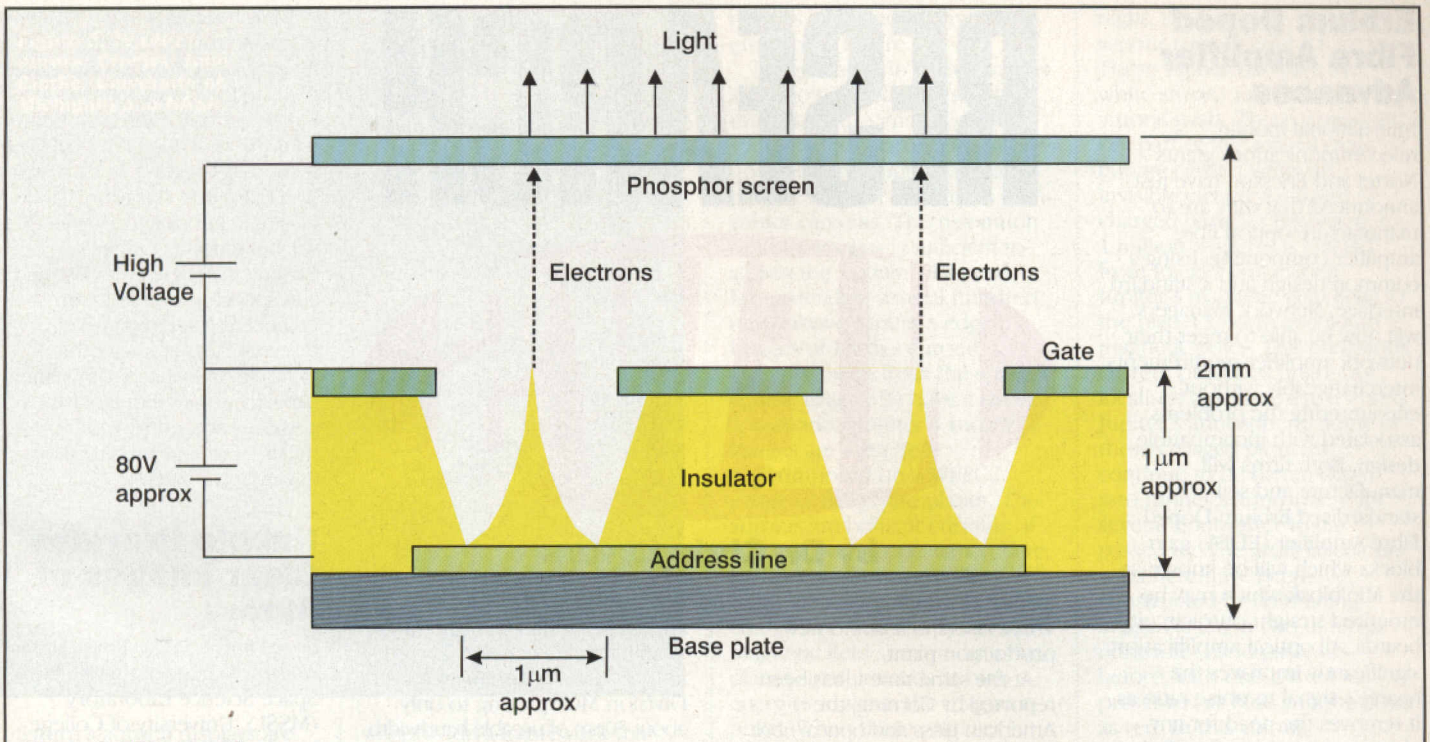


Figure 9. FED operation.

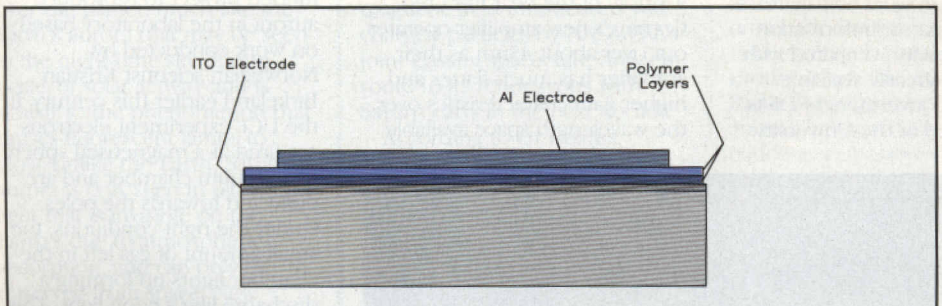


Figure 10. LED construction.


Photo 5. CDT LEP display.

The LED

The light emitting diode (LED) is already a proven display technology – but generally for large signs. Laboratories continue to make strides in developing new types – organic and inorganic; and LED displays have good brightness, contrast and response times. But whether they will prove to be ideal for flat screens in the office and home as many believe remains to be seen.

In a polymer LED (Figure 10) the polymer layers are sandwiched between charge injecting electrodes – in this case an indium tin oxide conductor below and a transparent aluminium electrode above. This lets out the light converted from the flow of electrons when a current is applied.

Finally, electroluminescent (EL) screens. Like LEDs the technology is familiar and is used for large public information displays, medical equipment, and such things where good visibility under a variety of conditions and viewing angles is essential. However, full colour products will require a much more complex manufacturing process.

An EL panel consists of luminescent phosphor layers sandwiched between transparent dielectric layers and then a matrix of row and column electrodes (Figure 11). When an electrical pulse is produced by the drive circuitry across the electrodes the phosphors emit light.

Despite the advances made by the various flat screen technologies in a relatively short time, the CRT still gives the best quality and by far the best value for TV and desktop computer use. Whereas for portable devices – computers, cameras, etc – LCD technology reigns supreme. And that is likely to be the state of play for some time to come.

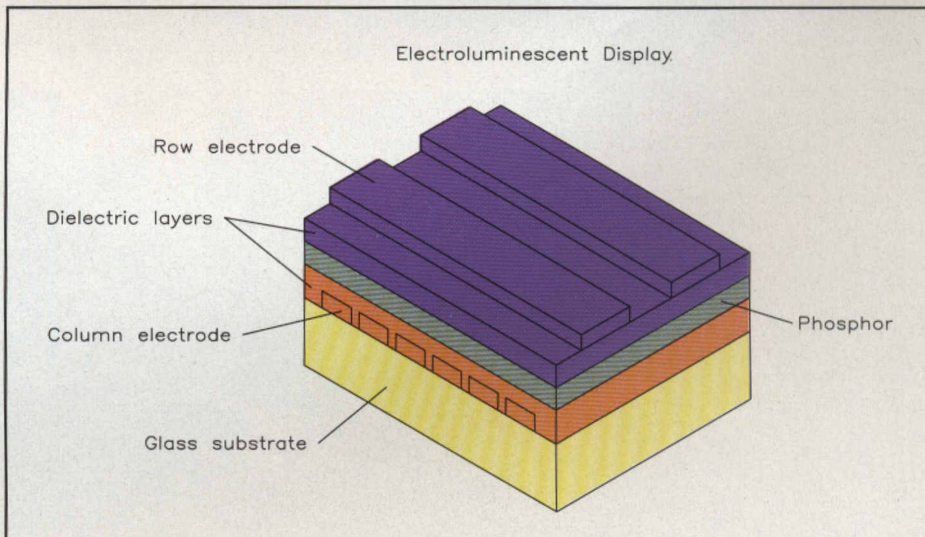


Figure 11. Electroluminescent construction.

RESEARCH NEWS

by Dr. Chris Lavers

Erbium Doped Fibre Amplifier Advances

International mobile telecommunications giants Nortel and Ericsson have just announced that they are to manufacture optical fibre amplifier components using a common design and a standard interface. Network managers will now be able to meet their network amplifier requirements interchangeably without encountering the problems associated with incompatible design. Both firms will manufacture and sell standardised Erbium-Doped Fibre Amplifier (EDFA) gain blocks which will be known as the Miniblock which may be mounted straight onto circuit boards. All optical amplification significantly improves the bearer's signal to noise ratio as it removes the need for any electronic amplification. Only time will tell if this will become the industry wide accepted standard. Ericsson Components is also expanding to meet the demands for fibre-optic components by forming Opto Electronic Products, manufacturing high speed WDM lasers in a brand new production plant.

At the same time it has been reported by Corning, the American glass and optical fibre manufacturer, that it has just developed a prototype silicate fibre which provides 50% increase in present channel information carrying capacity compared with other commercially available amplifiers. Conventional EDFAs, first reported at the University of Southampton's Electronics and Computing Department in 1985 by Mears et al are limited in their use of dense Wavelength Division Multiplexing to only about 30nm of useable bandwidth out of a potential 100nm in the 1550nm telecommunications window of the near infra-red. Corning's new amplifier operates out over about 45nm as their amplifier has much flatter and higher gain characteristics over the wavelength space available.

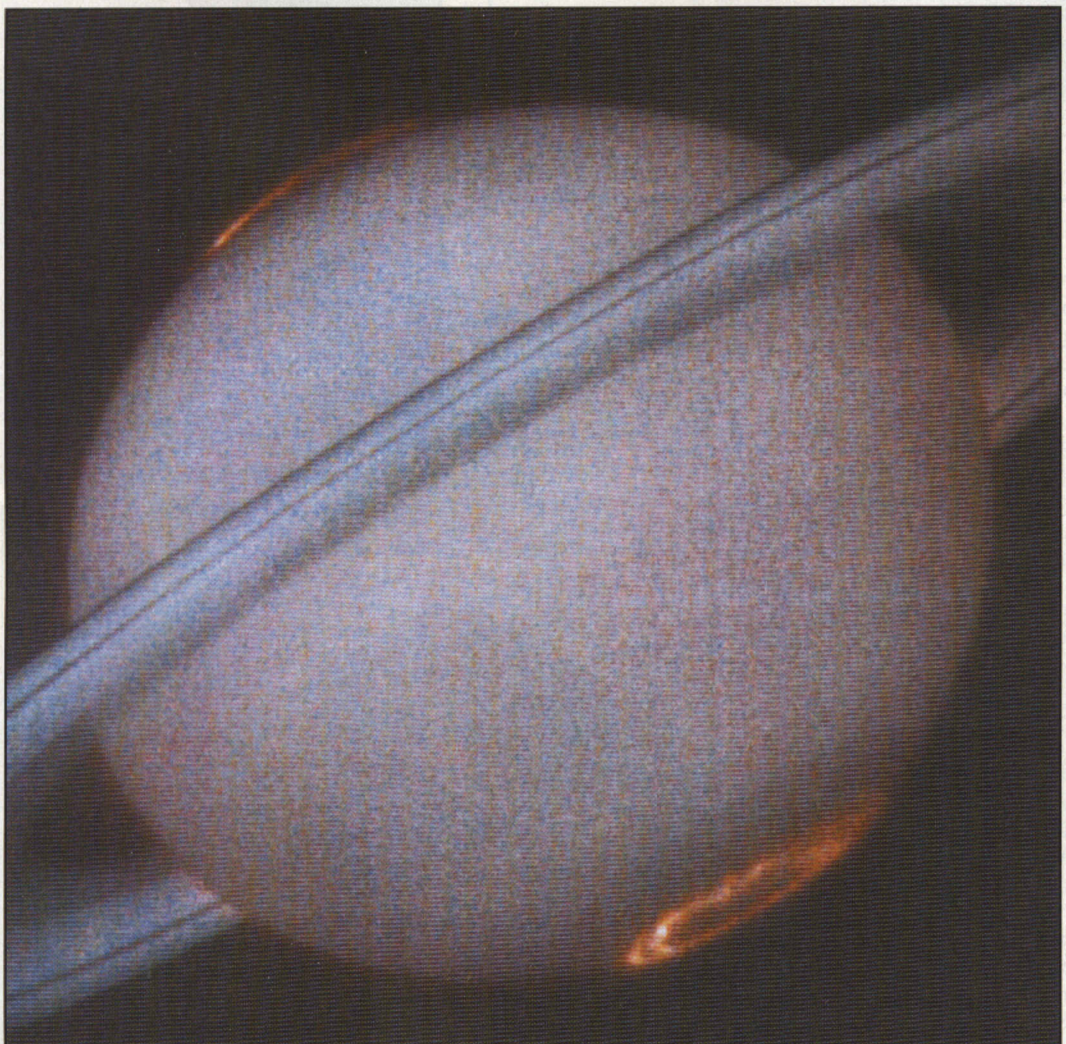


Figure 1. Saturn's aurora. Credits: J T Trauger (Jet Propulsion Laboratory) and NASA.

Whilst highlighting optoelectronics, Dundee's Abertay University has announced plans to build a major new Optoelectronics Research Centre focusing on the interface between technology and the human brain. The EPICentre (Electronic and Photonic Information Control) will build upon Dundee's existing expertise in optical signal and speech processing with engineering and psychology research. This is yet another example of Scotland's flourishing optoelectronics industry which currently accounts for £400 million a year of a multi-billion dollar global market.

Hubble Provides Clear Images of Aurora

Space and Climate Physicist Dr Andrew Coates of the Mullard Space Science Laboratory (MSSL), University of College London (UCL) is currently involved in a novel PPARC funded project to reproduce aurora in the laboratory based on work conducted by Norwegian scientist Kristian Birkeland earlier this century. In the UCL experiment electrons are fired at a magnetised sphere in a vacuum chamber and are deflected towards the poles. Under the right conditions, the small amount of gas left in the chamber lights up forming a discharge like a neon light. This is similar to the process happening in space which forms both the Northern and Southern lights, or aurora on the Earth and other planets. This information is being used as part of MSSL's work for the Cassini mission now on its way to Saturn, and for a resurrected Cluster mission to be launched in 2000. Cluster was originally planned to study the Earth's magnetic field environment and its response to communications disrupting solar storms. A portable version of Coates kit is planned to support public talks in the near future.

Coates explained that the first images of Saturn's ultraviolet aurora were taken by the Space Telescope Imaging Spectrograph (STIS) on board the Hubble Space Telescope in October 1997, when Saturn was at a distance of 810 million miles from Earth! The new camera provides more than ten times the sensitivity of previous Hubble instruments in the ultraviolet. STIS images reveal fascinating details never before seen in spectacular auroral curtains of light that encircle Saturn's north and south poles and rise more than a thousand miles above the cloud tops (Figure 1).

Figure 2. Jupiter's aurora. Credits: John Clarke (University of Michigan) and NASA.

Saturn's auroral displays are caused by the energetic solar wind from the sun that sweeps over the planet, much like the Earth's aurora that may be seen in the night-time sky during peaks of solar activity and is similar to the phenomenon that causes fluorescent lamps to glow. Unlike the Earth, Saturn's aurora is only seen in ultraviolet light that is invisible on the Earth's due to atmospheric absorption, and can only be observed from space. New Hubble images reveal ripples and patterns that evolve slowly with time. At the same time, these curtains shows rapid variations in local brightness which follows the planet's rotation on time scales of minutes. These variations and regularities indicate that the aurora is primarily shaped by the continual tug-of-war between Saturn's magnetic field and the flow of charged particles (the solar wind) from the Sun.

Study of Saturn's aurora began when Pioneer 11 first observed far ultraviolet (UV) emissions at Saturn's poles in 1979. The Saturn flybys of Voyager 1 and 2 in the early 1980's provided further evidence of the aurora and mapped the planet's enormous magnetic fields which guide energetic charged electrons into the atmosphere near the poles. The first images of Saturn's aurora were provided in 1994-1995 by the Hubble Space Telescope's (HST) Wide Field and Planetary Camera (WFPC2). The new STIS instrument provides greater UV sensitivity allowing the working of Saturn's magnetosphere and upper atmosphere to be studied in much greater detail. Hubble Aurora investigations will provide a framework that will ultimately complement in-situ measurements of Saturn's magnetic field interactions with charged particles by NASA/ESA's joint Cassini spacecraft, now en-route to its rendezvous with Saturn early in the next decade.

According to Dr Coates, Cassini will hopefully make measurements at Venus, Earth and Jupiter and sample the distant solar wind before finally arriving at Saturn. This will help in understanding the Earth-Solar-Interplanetary interactions crucial in predicting solar storms which can have devastating effects upon modern satellite communications. Two STIS imaging modes have been used to discriminate between UV emissions predominantly from hydrogen atoms (shown in red) and remissions due to molecular hydrogen (shown in blue). Hence the bright red aurora features are dominated by atomic hydrogen, while the white traces within them are the more tightly confined regions of molecular hydrogen emissions (Figure 2).

Images taken in the ultraviolet also shows unblurred short-time exposure images of oval-shaped objects around Jupiter's northern and south poles and provides higher resolution than earlier cameras. The resolution in these images is sufficient to shown the 'curtain' of auroral light extending several hundred miles above Jupiter's edge. Images of Earth's auroral curtains, taken from the space shuttle (Figure 3) have a similar appearance. Jupiter's auroral images are seen here superimposed on a WFPC2 image of the entire planet. The auroras are brilliant curtains of light in Jupiter's upper atmosphere. Jovian auroral storms, like Earth's develop when electrically charged particles trapped in the magnetic field surrounding the planet spiral inwards at high energies towards the magnetic poles. When these particles hit the upper atmosphere, they excite atoms and molecules causing them to glow when they drop back down the ground state.

Energetic electrons and protons from the sun strike the Earth's atmosphere, and the auroral lights remain concentrated above the night sky in response to the solar wind. Earth's auroras exhibit storms which may extend down to lower latitudes in response to increased solar activity. Jupiter's auroras however are caused by particles spewed out by volcanoes on Io, Jupiter's innermost large satellite. The effects of gravitational forces from Jupiter and other satellites, Europa especially, are literally tearing the planet apart, flexing the surface and causing heat to be released through the crust in dramatic volcanic eruptions. These charged particles are then magnetically trapped and start rotating around Jupiter, producing ovals of auroral light centred on the magnetic poles visible during both day and night. Both auroras clearly show vapour trails of light left by Io. These vapour trails are the white streaks just outside both auroral ovals. These streaks are not part of the auroral ovals, but are caused when an invisible electrical current of charged particles equivalent to 1 million amperes is ejected from Io, and flows along Jupiter's magnetic field lines to the planet's north and south magnetic poles. This enormous current produces bright but localised aurora where it enters Jupiter's atmosphere. Some of these charged particles continue to be driven down into Jupiter's atmosphere for several hours after Io has passed by. The artificial colours used here have been constructed by combining images taken in two different ultraviolet band passes as before, with one UV colour presented as blue and the other as red. In this colour representation, the planet's reflected sunlight appears brown, while the auroral emissions appear white or shades of blue or red.

Dr. Andrew Coates can be contacted via his e-mail address: **ajc@msl.ucl.ac.uk.**

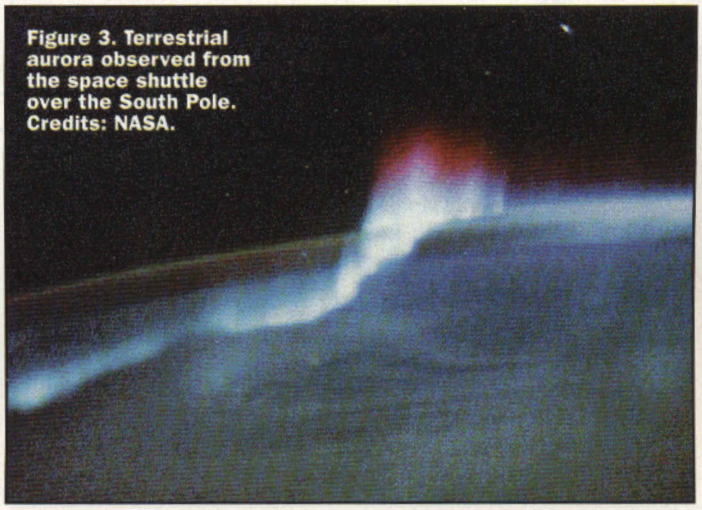


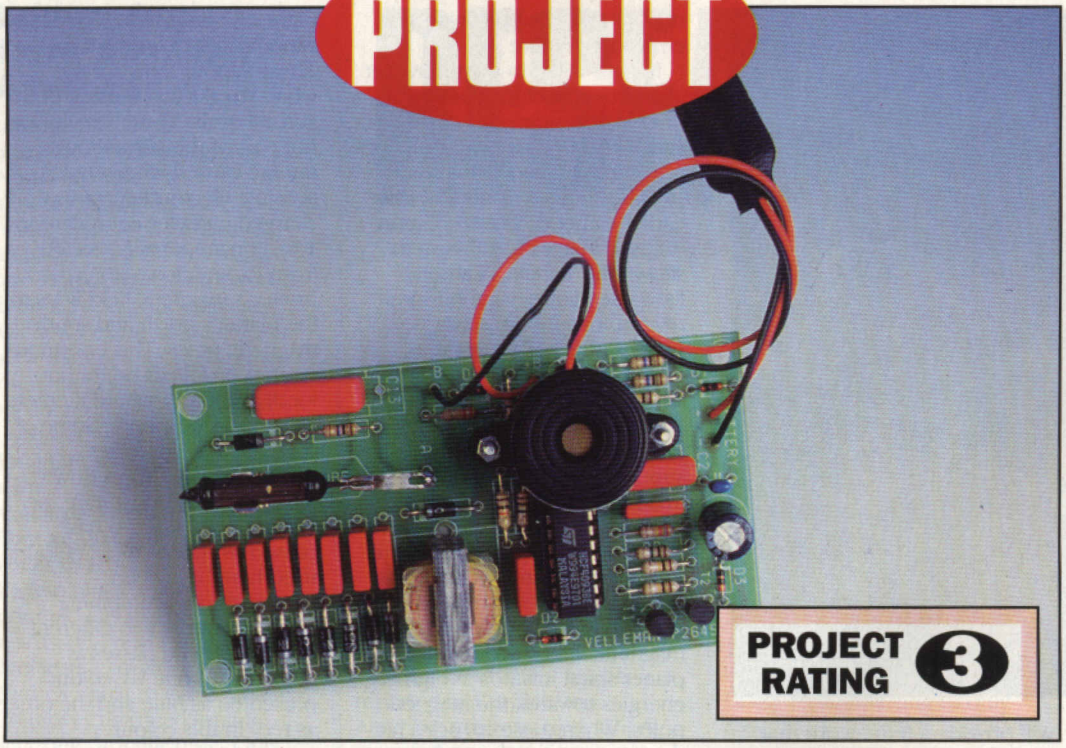
Figure 3. Terrestrial aurora observed from the space shuttle over the South Pole. Credits: NASA.

Forthcoming Electronics and Electronics related conferences

Two popular talks:

"Modelling Reality with Supercomputers" given by Professor Richard Catlow, of the Royal Institute will be given in Lecture Theatre 8W2.1 at the University of Bath on Wednesday 17th February: Contact: Dr P Ford Phone: 01225 826446, and

"Magnetic fields and mobile phone transmissions- an effect in or on the head", will be given by Dr Alan Preece of the Medical Physics Research Centre, University of Bristol at the HH Wills Physics Lab University of Bristol on Wednesday 17th March Contact: Professor B Gyorffy Phone: 0117 928 8704 Information provided thus far states that both meetings begin at 7.30PM, and light refreshments will be provided from 7.00PM. Visitors are always very welcome; there is no admission charge. The Twelfth Interdisciplinary Surface Science Conference will be held in Chester between the 29th-31st of March 1999 and will include one day at the nearby Daresbury Laboratory during which tours of the surface science facilities will be arranged. Contact: Dr T Turner, Daresbury Laboratory, Warrington, Cheshire WA4 4AD.



Geiger-Müller COUNTER KIT

John Mosely builds this Velleman kit and puts the finished item to the test.

SPECIFICATIONS

Sensitive to gamma and high-energy beta radiation

9V supply at typically 200μA – will last for 2 months continuous working

Small size PCB only 54 x 99 x 25mm

Introduction

Radioactivity is the spontaneous alteration of the nuclei of radioactive atoms, and is accompanied by the emission of radiation. It is the property exhibited by the radioactive isotopes of stable elements and all isotopes of radioactive elements, and can be either natural or induced. Radioactivity establishes an equilibrium in parts of the nuclei of unstable radioactive substances, eventually to form a stable nucleus i.e. a non-radioactive, stable, element. Frequently this results in the emission of alpha particles (helium nuclei), beta particles (electrons and positrons) or gamma radiation (electromagnetic waves of very high frequency). It takes place either directly, or indirectly, through a number of decays that transmute one element into another. The instability of the particle arrangements in the nucleus of a radioactive atom (the ratio of neutrons to protons and/or the total number of both) determines the lengths of the half-lives of the isotopes of that atom, which can range from fractions of a second to billions of years. All isotopes of relative atomic mass 210 and greater are radioactive. Alpha, beta, and gamma radiation are ionising in their effect and are therefore dangerous to body tissues, especially if a radioactive substance is ingested or inhaled.

Alpha rays are positive helium nuclei, and have strong ionising power but have relatively small penetrating power. The range in air of the most energetic alpha particles is only about 10cm, and can be stopped by a sheet of paper. They are completely stopped by the epidermis (outer dead layer of the skin) and because of this they do not present an external radiation hazard. Shielding against alpha particles is therefore unnecessary. However, as the body has no epidermis over internal tissues to protect them and because of the strong ionising effect of alpha particles they are a very serious internal hazard and great care must be exercised to ensure that alpha radioactivity is not digested into the body.

Beta rays are negative electrons that leave the nucleus at high speed. They do not exist in the nucleus but are created on disintegration – that is beta decay which is when a neutron converts to a proton to emit an electron. Beta particles are more penetrating than alpha particles, but less so than gamma radiation, and can have a range of 5m in air and 1cm in organic material, but are stopped by 2-3mm of aluminium. The skin and the lens of the eye are the most susceptible organs and serious damage can result to both from large exposures to beta radiation.

Gamma rays are very high-frequency electromagnetic radiation, similar in nature to X-rays but of shorter wavelength, that are emitted by the nuclei of radioactive substances during decay or by the interactions of high-energy electrons with matter. They have a greater penetration in most materials, and are stopped only by direct collision with an atom and are therefore very penetrating. Lead that is 4cm thick or a very thick concrete shield will stop them. They are less ionizing in their effect than alpha and beta particles, but are extremely dangerous as they can penetrate deeply into body tissues such as bone marrow. They are not deflected by either magnetic or electric fields. X-rays are very weak types of gamma rays.

Every radioactive element has its own specific half-life, and different kinds of radioactive atoms have very different half-lives ranging from fractions of a second to millions of years. Cosmic rays and radioactive minerals in the earth are known as natural radioactivity – radon gas being a by product of the latter.

Although external exposure to alpha and beta radiation is generally not very harmful, except to the skin, when the exposure is internal through breathing contaminated air or eating contaminated food, then the effects can be far more serious. In certain cases this can result in lung cancer, or genetic damage. Also some elements can accumulate in certain parts of the body such as the thyroid gland.

This kit is designed to measure the level of beta and gamma radiation, and is relatively easy to construct, and should easily be completed in an evening.

Alphas are not detected with this tube because it has a complete glass envelope. Other GM tubes have mica windows to allow alphas through.

The Geiger-Müller Tube

Gregg Grant in part 3 of his series 'Radioactivity – A Century of Controversy' (Electronic and Beyond issue 128, August 98) provides an excellent description

of the Geiger-Müller (G-M) tube and radioactivity measurement. So I will only give here a brief description of the G-M tube.

The tube consists of a gas between two electrodes one of which, the cathode, is a hollow cylinder. The other, a fine wire stretched along the cylinder's axis, is the anode. This carries a potential of around 600V. A charged particle passing through the tube will ionise the enclosed gas, and produce an electron from the collision which will be attracted to the central wire. During this attraction process the electron will collide with further gas atoms. As a result of the intense electric field near the central wire, the electron can acquire enough energy between collisions to enable it to ionise another atom. A second electron is set free and, through successive collisions, an avalanche of electrons collect as a charge on the central wire, producing an electrical impulse which, typically, can be some tens of volts. This pulse is independent of both the energy and nature of the particle that liberated the electrons within the gas and the counter operation depends critically on the voltage on the central wire. If this is too high, additional electrons produced by the positive ions begin additional discharges and the counter discharges continuously. If the voltage is too low however, an electron avalanche never takes place and the counter simply acts as an ionisation chamber, or a proportional counter, in which the output pulses are far smaller.

How it Works

IC1a and IC1b form the basis of a slow running oscillator, the output of IC1b goes positive for a few hundred milliseconds every 10 seconds. The output triggers the other oscillator formed by IC2a and IC1c. The outputs are used to alternatively switch TR1,2 via IC2b,c. An AC voltage is developed across the primary of transformer TRAF01, which produces a stepped up voltage on its secondary. A conventional voltage multiplier circuit (D5-13, C5-C12) further steps-up the voltage to 600V. C13 acts as a reservoir capacitor.

The pulse output from the tube, caused as a result of radiation detection, triggers the monostable oscillator IC2d and IC1f, via invertor IC1e. this produces a 100ms beep, which is heard via a single transistor amplifier TR3 and a small piezo sounder. The more radioactive particles that hit the G-M tube then the more beeps produced.

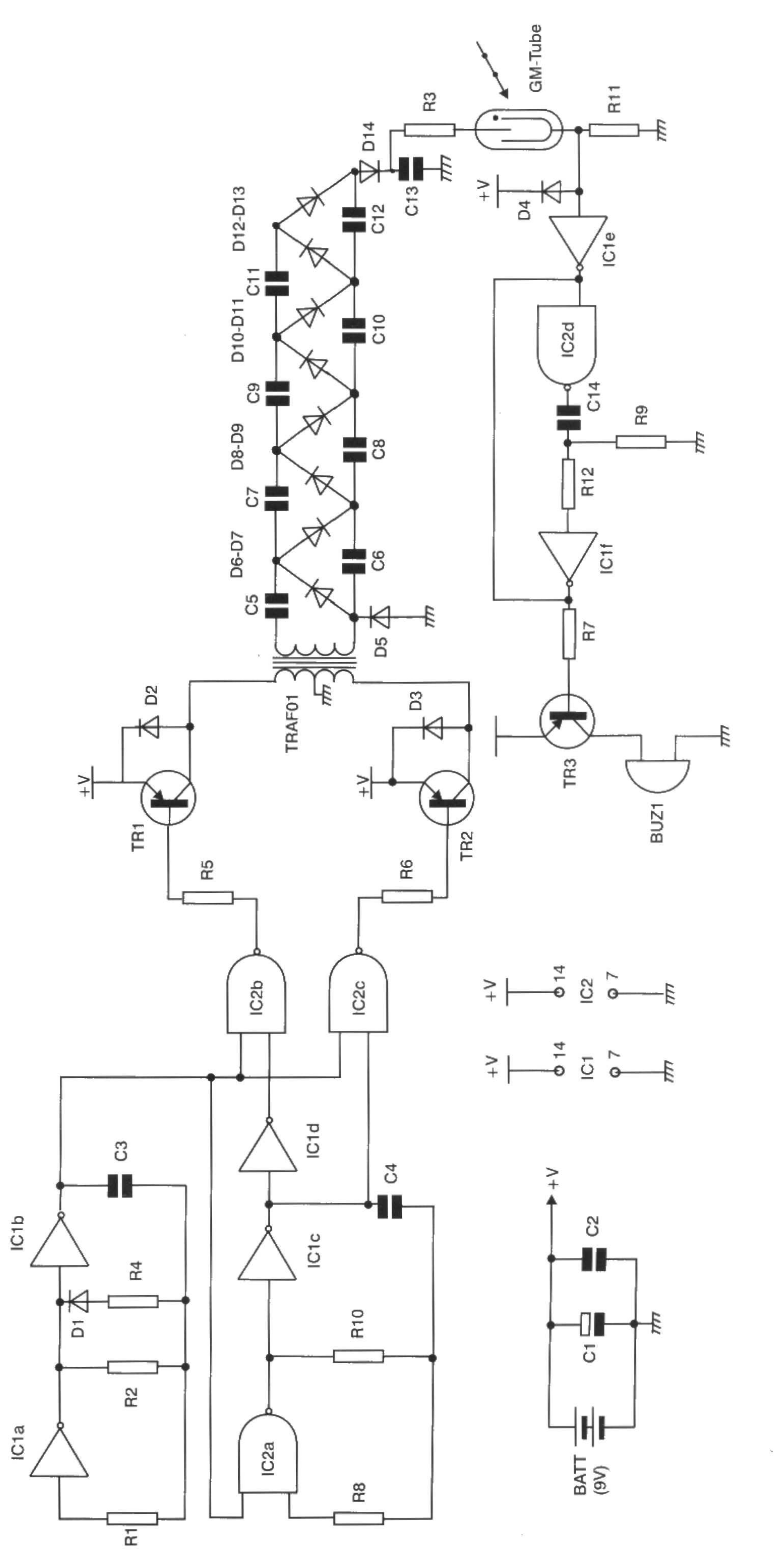


Figure 1. Complete Circuit.

Construction

Mount all the resistors and capacitors first. It is important to pay particular attention to the mounting of the capacitors, as they are very similar and it is therefore very easy to put the wrong value in, especially as the PCB has multiple holes for the high voltage capacitors to allow for differing sizes/types/ manufacturer. This could be potentially dangerous, as many of the capacitors are rated at 250V, and the reservoir one at 1000V. It is possible that the reservoir capacitor C13 is made up of one 33nF/1000V type or two 47nF/400V types in series. In the kit I had it was one 33nF/1000V type.

The diodes can be mounted next followed by one link wire (supplied!), the IC sockets and the transistors. The transformer can be mounted next and it is worth straightening the five wire legs before hand so that they line-up with their respective holes. The battery connector and ICs can now be inserted. The sounder is mounted above IC1 using two supplied spacers and suitable nuts and bolts.

At this stage do check all your soldering, for dry joints and any solder blobs that may be shorting out tracks, again remember that there are high voltages present on a large part of the board.

Last, but not least, you will need to mount the G-M tube. Remember this small device contributes by far the most to the cost of this kit – over two thirds – so be very careful and follow the instructions carefully. Remember, under no circumstances must you solder direct to the tube. A clip is included in the kit which holds the tube and forms the cathode connection. This clip is a PCB mounting fuse holder type, and as such as a small bent piece on one side of the holder, on both halves of the clip. These would normally prevent lateral movement of a fuse, and in this application they need to be removed or carefully bent back. I used a pair of small long-nose pliers to bend these pieces straight.

A clip is supplied with the tube which fits on to the anode pin. This very gently needs to be removed and soldered at a height of 2cm above the board, using a piece of stiff wire. You may find an extra pair of hands useful for this operation. There is also a small metal ribbon wrapped round the tube, this is not needed and can safely be removed and disregarded. If all is correct then the tube can be gently insert into the anode clip and pushed into the cathode clip.

Testing

When you are satisfied all is correct, then connect a 9V PP3 battery. Do not be surprised if nothing happens! It may be several seconds or even tens of seconds before you hear a loud beep. In normal radiation conditions you can only expect to hear less than 10 beeps per minute. At home and in the Maplin Office at Hadleigh, we heard less than this amount although there were times when two beeps were heard in quick succession. If you hear more than 20 beeps per minute, then you are in an unhealthy environment.

The two main units of radiation dose are the REM (Röntgen Equivalent Man) which is equal to the amount that produces the same damage to humans as one Röntgen of high voltage X-rays. The Sievert is an SI-coherent unit and equals 8.83 Röntgen or 1mCurie of intensity per hour. Both these units are a measure of biological damage, and the International Commission on Radiological Protection, stated that 500 millirem per year was the maximum permitted exposure to human sensitive body parts and bone marrow. Naturally occurring radiation accounts for about one fifth of this maximum dose. A chart is included with the kit to relate count rate to dose, so that a count of 2.5 per second i.e. 25 beeps per 10 seconds, is equivalent to 1millirem/hour.

For convenience, the project can be mounted in a small plastic box. Some small holes above the sounder and one in front of the G-M tube would be required. You may wish to mount a small single-pole on/off switch to conserve battery power, although Velleman claim the detector will run continuously for two months. It is worth remembering that although the HT circuitry is at a very high impedance, you can still get a shock if you inadvertently touch components in this area. When you remove power, the unit will keep working for several seconds until all the charge leaks away, so be careful when testing the unit.

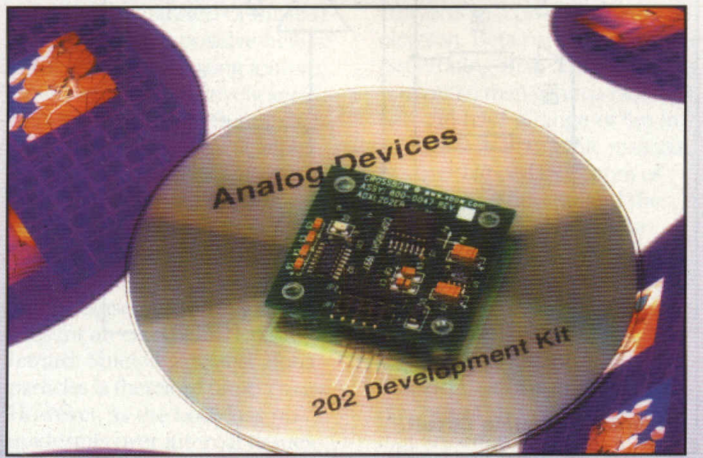
Note that the Geiger-Müller tube PCB and transformer are not available separately.

PROJECT PARTS LIST

RESISTORS	
R1,2,3	10M
R4-7	100k
R8,9	1M
R10,11	220k
R12	10k
CAPACITORS	
C1	220µF 16V Electrolytic
C2	100nF 63V
C3	1µF 63V
C4	1nF 630V
C5-12	33nF 250V
C13	33nF 1000V, or two 47nF 400V in series
C14	47nF 250V
SEMICONDUCTORS	
D1-4	1N1418 or 1N916
D5-14	1N4007
T1-3	BC557B
IC1	40106
IC2	4093
MISCELLANEOUS	
	PCB
	Geiger-Müller Tube
	Step-Up Transformer
	Piezo Sounder
	Spacers
	PP3 9V Battery
	Plastic Box

Accelerometer Evaluation Made Easy

Maplin are now able to supply a low cost evaluation kit for the Analog Devices ADXL202 accelerometer. The ADXL202EB-232 Kit comprises a microcontroller based evaluation board which can be hooked-up to the serial communication port of a PC, together with a CD-ROM containing full documentation and demonstration software. The demonstration software enables the user to interactively monitor and evaluate the system performance of the ADXL202 in a variety of configurations.



The ADXL202 2g dual-axis accelerometer is ideal for many low-g applications such as car alarms, appliance vibration control, tilt and motion measurement etc. Available in a space saving surface mount package, the ADXL202 provides a low power (typically <0.6mA), low voltage (2.7V to 5.25V), high sensitivity (5x10^{-2} ms^{-2}) fully integrated sensor solution.

Type	Order Code	Price inc. VAT
ADXL202EB	PV40T	£87.25
ADXL202	OA23A	£26.34

SMC DVD PLAYER

We try out this new entertainment media and give you the low down.

For those readers who regular subscribe to and read Electronics and Beyond, will have read at various times articles and comments about DVD. Martin Pipe in his article Technology Watch in the November issue gave an excellent account of the system. They are now appearing in shops and catalogues, and Maplin has decided to enter the market. We were fortunate at the editorial office to receive a machine for evaluation, and I have to say, as a system, it takes some beating!

Such players are relatively expensive – considering at the present time they are only players and not recorders as well – this is because of the sophisticated technology required to compress a feature film, plus copious amounts of sound, on to 4.7Gb, or more, discs. The DVD uses the same MPEG-2 compression system used by digital TV broadcasters, and includes multiple stereo soundtracks, which are also compressed to the MPEG standard. Most of the DVD films that are now becoming available in the UK have a Dolby Soundtrack, which offers a stunning sound quality.

DVD video offers some startling new features, which should eventually be available on all discs sold. The ability to select different camera angles for instance is one feature you do not get at the cinema. There is also superior quality still-frame and slow motion, a rating system to restrict what children can see, and the ability to select the aspect ratio to match your television.

Features

So just what does the SMC DVD 330 offer? The answer is a great deal as it will play not only video but audio plus Karaoke facilities.

The other bonus is that this machine will play any DVD disc. DVD video is intended to be regionalised, so that the industry can effectivley maximise profits. The DVD world has been split into six regions, so that each DVD disc has its intended region code imprinted somewhere on the disc. This code has to match the region code hardware constructed into the player, if it doesn't then you have wasted your money! The USA has been designated Region 1, with Europe as Region 2. If you choose to buy a film while on holiday in the USA, (or over the Internet) then this machine will play it.

The machine offers various screen formats such as standard 4:3, 16:9, pan, letter-box et., plus a 'parental lock' feature which allows the user to restrict the playback level of a DVD film. The scenes on a film can be adjusted to any of eight possible parental-lock levels for restrictive viewing.

In Use

As a starter, I plugged the audio output in to my hi-fi system to hear a standard audio CD. The result was, as expected, extremely good. The controls are simple and easy-to-use, and the only real difference to using a 'proper' CD player is that the machine did take longer to sort out the type of disc inserted. Once playing, it was capable of all the usual features. I would not put it in the league of correspondingly priced audio CD players, but it was better than the average system CD player.

In order to play a DVD film I had to go and buy one! I often go to computer fairs held at the weekend in the south east Essex area, and DVD films are now being sold at these fairs. The prices have been about £17/18 for a current film. On this occasion I chose to go to the HMV store in Southend where a small selection was on sale. Prices ranged from £18 to £23 for the latest James Bond offering. I understand that Blockbuster Video Rental are proposing to trial DVD rental in about 30 outlets, so hopefully, availability and choice will improve considerably in the near future.

It was difficult to fault the picture and sound quality, both being excellent. In order to give justice to the player then I would advocate a large screen television – even the wide screen variety with surround sound speaker system to match. Still image, slow motion and 'fast forward' all naturally match this quality, with no jitter or banding.

The films are divided into chapters so that you can easily find a particular section, and if you stop, an internally generated caption appears which disappears when you press play and the film continues from that point – ideal for natural breaks.

Operating functions are available from the remote control and the setup procedures can be a little involved – this is not surprising considering the number of facilities offered, such as audio and video setup which can be tailored to individual requirements. Sub-titles are another worthwhile feature.

Allegedly, every disk has a Macrovision encoder built-in to prevent the disc from being used as a high-quality master for pirate videos, and dubbing for your own use so I connected the SCART lead to my video to see the result. I experienced the expected video level variations, which when played back where even worse with loss of colour and contrast. You certainly could not record a watchable tape.

I did not have a Karaoke disc so was unable to test this side of the machine, but two mic inputs with individual controls are supplied plus an echo control.

Conclusion

If you are someone who enjoys watching films, then this is for you. If you take into account that I recently spent about £15 (for two including 'incidentals') on a Saturday night to go to the cinema then £18-20 for a disk becomes a viable alternative. Add to this the ability to play audio CDs, then the SMC player can certainly form the heart of an audio/video home entertainment system, but remember, to fully appreciate the output you will need a suitable television with speakers.

SPECIFICATION

Type of disc:	DVD, VCD 1.0, 1.1 and 2.0 CD-DA CDi-FMV
Video Format:	MPEG 1, Version 2.0, MPEG 2
Audio Format:	MPEG1, layer 2, standard LPCM, Dolby Digital
Signal o/p	
video:	NTSC/PAL 1.0V pk-pk (75Ω)
audio:	2V rms
Karaoke:	echo control and vocal cut
I/P connector:	2 front panel mic
O/P connector:	S-video, IEC 1937 optical, SCART, phonos
Audio response:	20Hz to 20kHz
S/N ratio:	>90dB
Distortion:	<0.05%
Dimensions:	430 x 280 x 95mm

PSYCHO-KINETIC BIO-FEEDBACK TRAINER & MOVEMENT DETECTOR

Photo 1. Complete Unit

PART 5

In part five, David Aldous completes the construction and provides a parts list.

Sensing Head

The marking, drilling and cutting-out for this is fairly simple in comparison to the main unit, since the material is much thinner and easier to work. However, it is also more delicate and care must be taken not to apply too much pressure when carrying out these operations in order to avoid damage.

For the front panel (Figure 1) the marking-out, drilling, and cutting techniques are exactly the same as for the main unit. All the front panel holes should be marked out with the HB pencil, and the ruler-measurements made as shown. To avoid splitting the front panel, the large holes for the tweeter loudspeaker and the A.F. microphone shroud should be made last, after all other front panel holes have been drilled out to the sizes shown. Note that the four mounting holes for the tweeter are drilled out to 1/4"/6.5mm, since they will be fitted with small rubber grommets which act as acoustic dampers, so reducing direct signal feed to the microphone.

The bottom edge (Figure 2) requires carefully drilling, since errors will affect the alignment of the small video camera tripod which will be used with this unit. The most critical hole is the one carrying the mounting bush for the tripod. This hole should first be drilled out to 1/4"/6.5mm and then very carefully opened out evenly, until the 3/8"-to-1/4" camera mounting bush adaptor can be just engaged. The coarse thread on this bush can then be turned with the aid of a wide-bladed, stubby screwdriver, to cut a thread into the plastic and so lock-in to the box. The amount of turn should be enough to set the surface of the bush flush with the surface of the box. This gives a solid anchorage, since the threads are actually cutting into the central stiffening rib/PCB mounting slot.

On the side of the box (Figure 3) there are two 4mm diameter holes to accommodate the 4mm nylon bolts used to mount the PCB. The outward measurements are referenced to a central line drawn up the side of the box and the other measurements are referenced to the base edge of the box (minus lid). This completes the marking, drilling, and cutting out of the sensing head.

For the back panel, or box lid, (Figure 4) the most critical part of this is the alignment and cutting out of the hole for the 9-way 'D' connector. The method is exactly the same as for the corresponding hole on the forward panel of the main unit. The accuracy of measurement for the vertical position of the connector is critical, owing to the need to ensure alignment of these two areas when the two units are plugged together.

Panel Labeling

Only the main unit carries labeling. There are several possible methods by which the necessary legends can be applied. The author used rub-down transfers on the prototype e.g. Lettraset, in order to keep down the cost.

Mechanical Assembly

On the main unit all the controls should be tried in their respective panel holes, and any minor adjustments to hole sizes

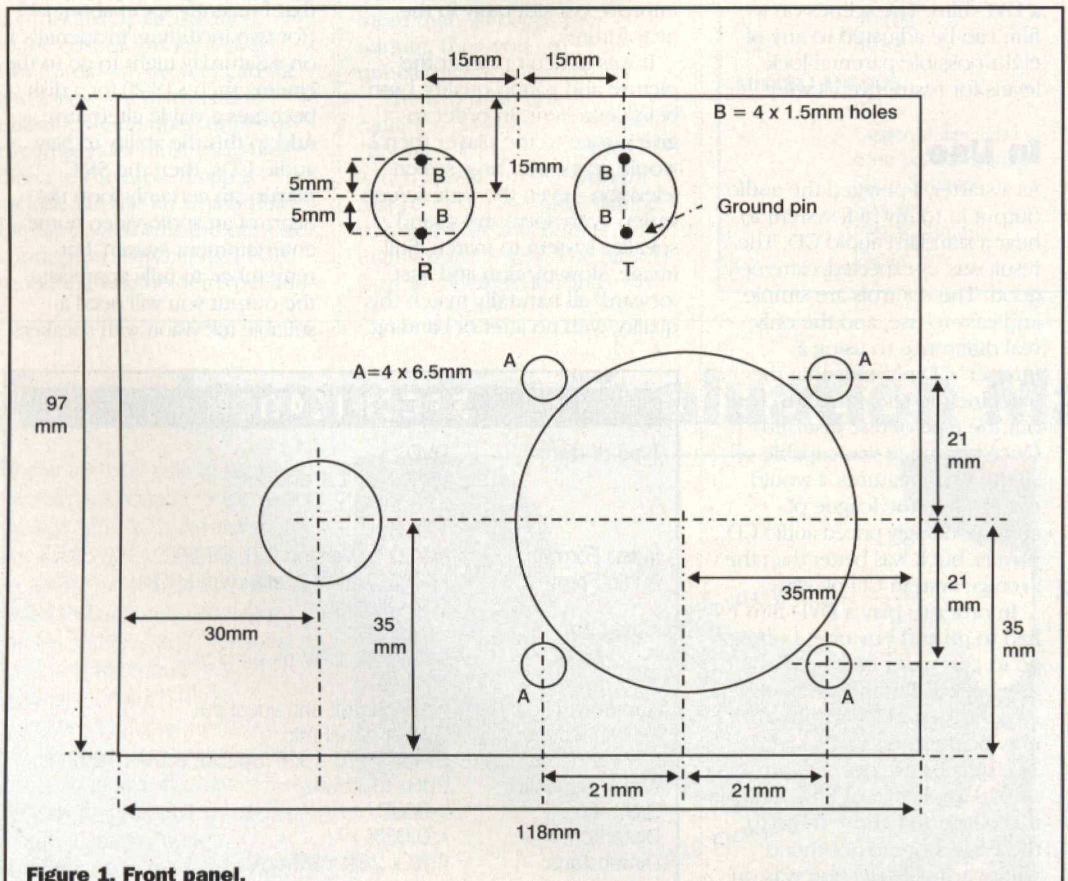


Figure 1. Front panel.

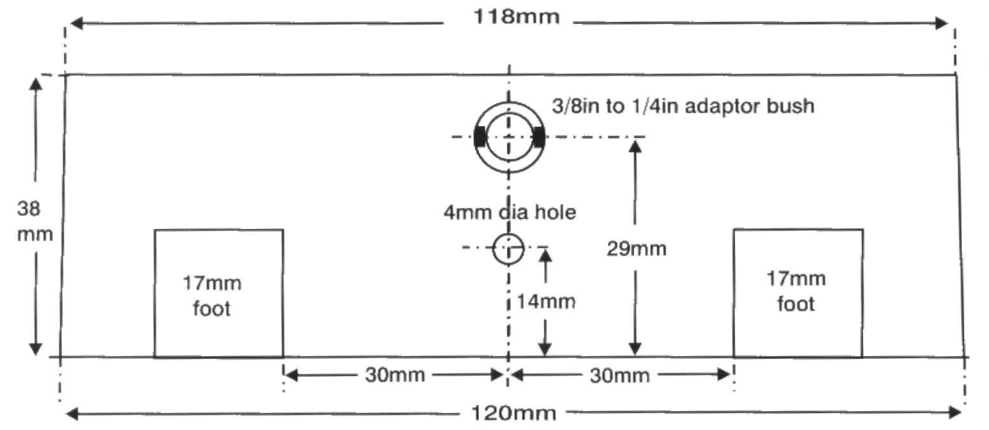


Figure 2. Base view.

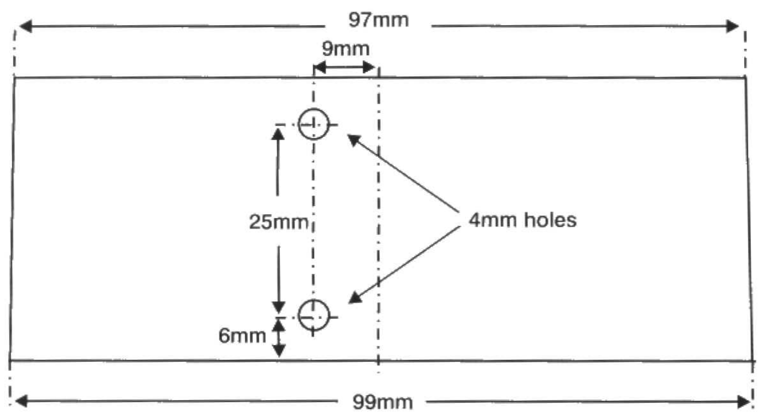


Figure 3. Left end view.

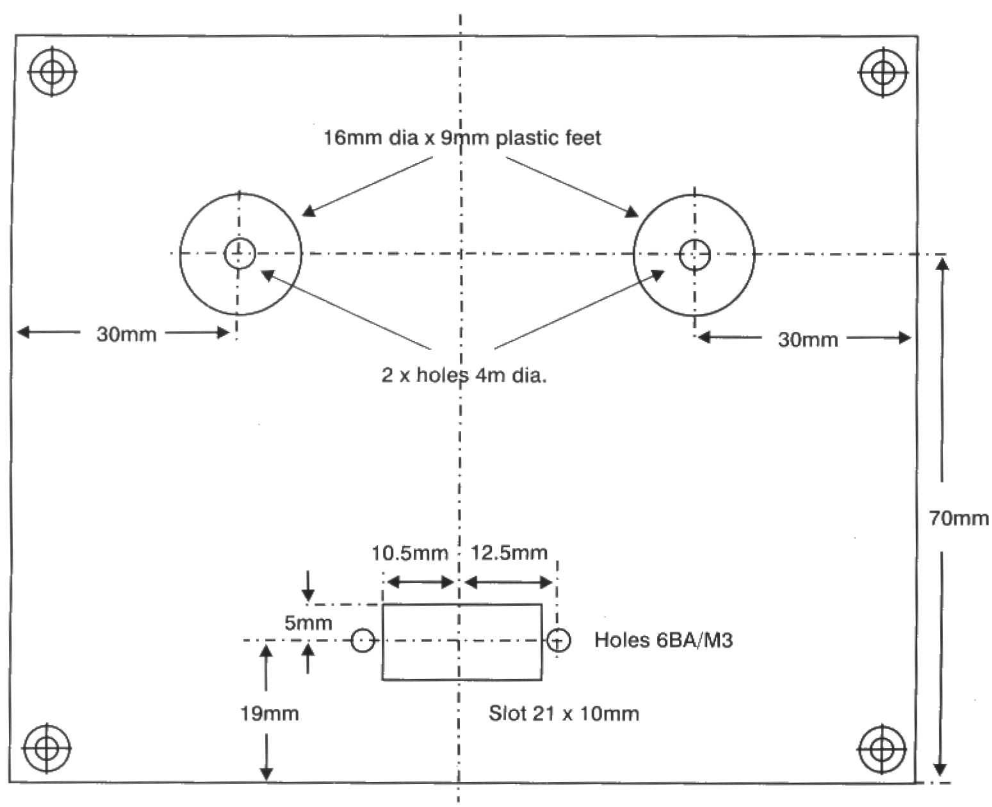


Figure 4. Back panel.

made before full assembly is attempted. The meter should be tried and checked to ensure square alignment with the top edge of the top panel. If satisfactory, remove the meter and put this on one side to be fitted last of all, in order to avoid unnecessary risk of damage to the movement by excess handling, or accidental scratching of the meter face. Next, cut down all control shafts on the potentiometers and rotary switches. Note that if the transfer method of panel labeling is used, then the switch shafts should be shortened first, as the switches are used with the temporarily fitted control knobs to generate the datum marks for the switch detent positions. The final shaft length should in all cases be 9.5mm, as measured from the shaft-end of the mounting bush. Each control should have a suitably sized 'star' washer and appropriate control mounting nut. In order to ensure that control knobs seat close to the panel, the technique for mounting the controls will involve the removal of any anti-rotation spigots usually provided. This is best done in the case of metal tab spigots, by bending them back flat with a pair of snipe-nosed pliers. In the case of the aluminium pin types, these are best removed by breaking them off with a small pair of pliers. The specified rotary switches have plastic spigots, and these can simply be cut-off flush with the case by means of side cutters. Note that in the case of the rotary switches, the number of rotation steps must be set before assembly. The types specified are fitted with an adjustable stop ring and pin. To set the required stop, simply drop the pin extension on this ring into the hole corresponding to the number of steps required. After setting, fit the 'star' washer onto the bush and pass the bush through the appropriate panel hole, *taking care not to allow the stop ring to disengage from the required stop setting.* Next, fit the control nut to the bush and hand-tighten to temporarily secure the switch. The exact rotary alignment of the switch is set by finding the mid-position (step 2 for the 3-way OUTPUT selector switch; step 3 for the 5-way F.M. RESPONSE switch. There is a flat on the control shaft on both switches and the control knob should next be fitted and tightened with the screw on this flat. If the body of the

switch is now firmly grasped, it can be rotated until the arrow point on the knob skirt points to the mid-position setting. Carefully release the knob clamp screw and whilst holding the switch firmly, tighten the control nut with a suitable spanner to lock the control, taking care not to over-tighten to avoid stripping the plastic threads on the bush. How tight this should be is a matter of judgement, but a reasonable amount of resistance should be felt, and the switch should not move when attempting to gently rotate the body of the switch by hand. All the other controls should now be fitted to give maximum accessibility for wiring.

Other Components

On the top panel mount the meter next and tighten the mounting nuts, after ensuring that the top edge of the meter is parallel with the top edge of the box. Next, fit the solder tags to the meter terminals and tighten the nuts.

The mode switch is fitted with the large, flat, tabbed washer on the outside of the box. The tab should be placed in the small pilot hole made for it, and the nut fitted and tightened.

For the status LEDs, the mounting hardware used on the authors unit was the standard bush and ring variety, although better hardware is available. The hardware used will determine if any further hole adjustments are needed. The left-hand LED is a 5mm green type and the right-hand one a 5mm red type.

The cursor LEDs are all 3mm RED types and are a tight push fit into the relevant holes. They are fitted from inside the box, using the tips of a small pair of pliers to push them into position. If they happen to be slightly loose, then a drop of superglue will take care of the problem.

On the side panel fit the small slide switch for LEDs ON/OFF. Now fit the power connector with the anti-turn washer on the outside of the box and tighten the nut firmly.

On the forward panel fit the 9-way 'D' connector socket, SK1, to the forward panel, ensuring that the wide part is uppermost. Mount SK1 with two countersunk headed 6BA/M3 bolts, and a single plain washer fitted between each connector tab and the panel to act as a spacer. *Do not forget* to fit the bail lock tabs and springs, which are used to lock the extension cable plug in position. These fit over the top of each tab and with the spring pivots away from the panel. The reason for using countersunk headed bolts here, is so that these screw heads do not foul the heads of the mounting bolts on the sensing head unit when this is plugged directly into the main unit. Next fit the two brass eyelet rings. These simply self-tap into the holes drilled for them and can be tightened with the aid of a pair of broad nosed pliers. Screw these in as far as they will go, but take care not to over tighten, lest they break off. Ensure that the rings are horizontal when finally screwed in place. These form the anchorage for the rubber support strap, used to clamp the sensing head in place when plugged directly into the main unit

Four phono connectors are mounted on the back panel using the hardware supplied. Ensure that each solder tag is pointing towards the base of the box so that it is accessible. Fit the two speakers next, using the following technique. Use six 4BA/M4 solder tags which are bent to form shaped brackets. Pass 4BA/M4 pan head bolts through each vertically aligned pair of mounting holes, and fit a shaped solder tag over each bolt, with the bent tab away from the panel. Fit a shakeproof washer and nut over each bolt and tighten, ensuring that the tabs of the solder tags point towards the centre of the speaker mounting position. Finally, fit the speakers by pushing the edge under the bent tabs, then pass the remaining 4BA/M4 bolt through the panel, and fit the remaining solder tags to these bolts in the same manner as previously. Fit a shakeproof washer and nut on each bolt and tighten. The result is a low cost, 3-point clamp for each speaker. Next, fit each jack socket in its appropriate position, taking care to ensure that the tags are accessible. Fit the appropriate mounting ring to the outside of the box and tighten with the aid of a pair of fine, snipe-nosed pliers, or a circlip fitting tool.

On the base (box lid), the four 4BA/M4 nylon bolts are passed through the holes and secured using a 4BA/M4 nylon flange nut. Note that these nuts are fitted with the flange away from the panel. This allows the flange to form a firm bed for the PCB to rest on. This completes the mechanical assembly of the main unit.

Mechanical Assembly – Sensing Head

For the front panel fit a 6.5mm rubber or plastic grommet to each of the four panel holes (A) for the tweeter loudspeaker. Fit the speaker to the front panel and mount with four, 4BA/M4 pan head bolts and nuts, using a suitable washer under each nut to protect the grommet. Tighten firmly, but not excessively, so as not to compress the grommets too firmly, else this will defeat the objective of providing a simple but effective form of mechanical damping. Next, fit the microphone shroud (note this is actually a Weller soldering iron receptacle and should be a tight push fit into the panel). A 1in Jubilee clip is used to hold this in place, but it can instead be superglued in place if desired. If the Jubilee clip is used, ensure that it is fitted with the orientation shown to avoid fouling the PCB. Next, fit the two ultrasonic transducers with the receiver on the left and transmitter on the right. Fitting is very simple and entails placing a pea-sized piece of Blue-Tac, suitably flattened, behind each transducer to act as a mounting pad and pressing the transducer hard against the panel until the case seats against it, after the wire leads are passed through the 1.5mm holes. Ensure that the lead connected to each transducer case is sited in the lower hole of each pair of holes. The leads are then simply bent outwards inside the box to secure each transducer. At this point, the two 17mm, self-adhesive rubber feet can also be fitted to the bottom edge of the box (See Figure 2).

The side mounting PCB uses two 4BA nylon bolts for mounting the PCB with two 4BA nylon flanged nuts fitted with the flanged side towards the PCB to form a firm mounting bed for it.

Next to be completed is the back panel (box lid) which simply requires that the 9-way 'D' connector plug, PL1, to be mounted using two of the special M3 assembly pillars and appropriate nuts and washers. *Take care to fit this connector with the wide part at the top.* The two 16mm diameter x 9mm deep, soft, plastic feet which act as spacers when the sensing head is plugged directly into the main unit, are fitted next, using 4BA/M4 nuts, bolts, and washers. Tighten these firmly but not excessively. Two nuts are used to form a locknut assembly. This completes the mechanical assembly of the sensing head.

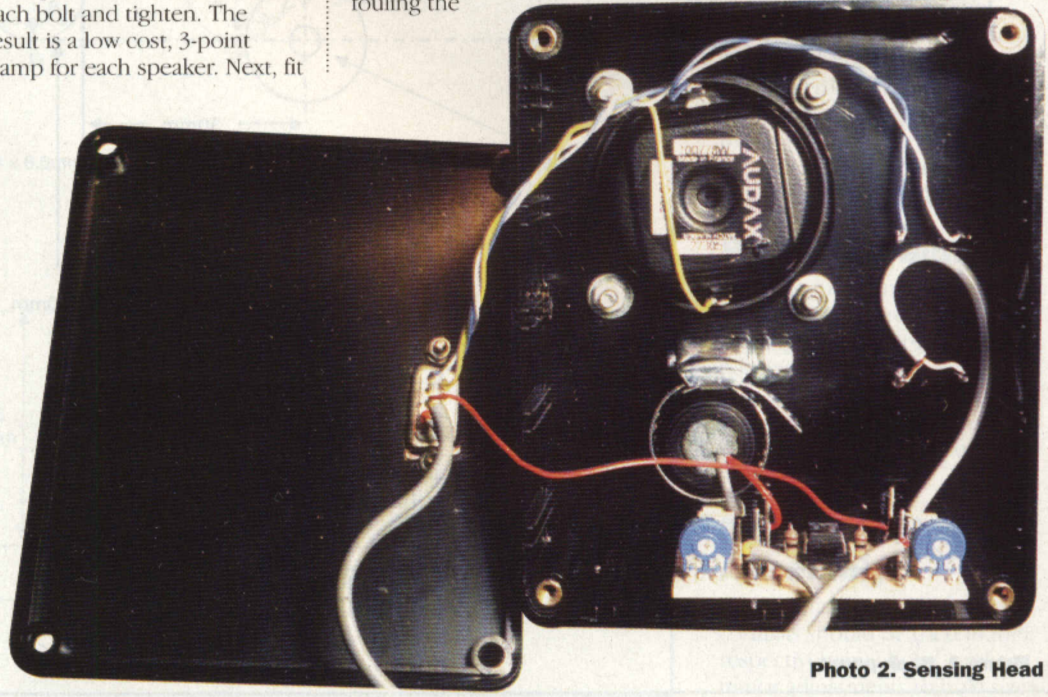


Photo 2. Sensing Head

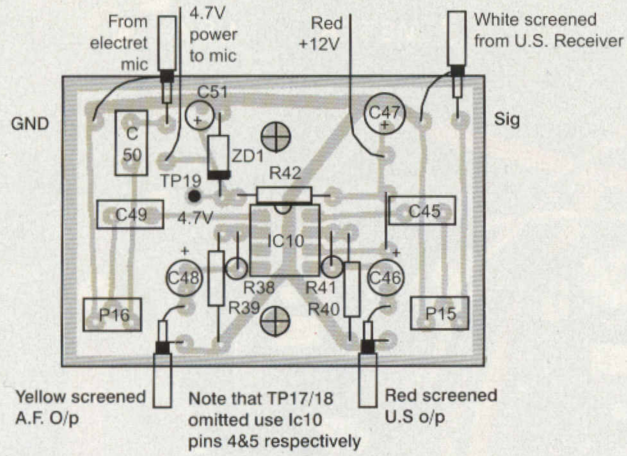


Figure 5a. Component overlay of sensing head.

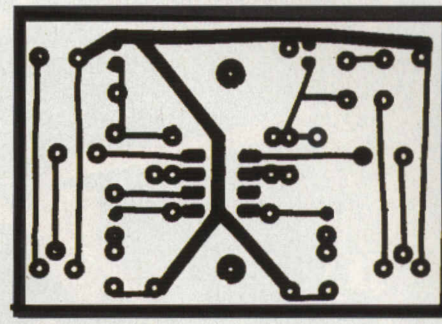
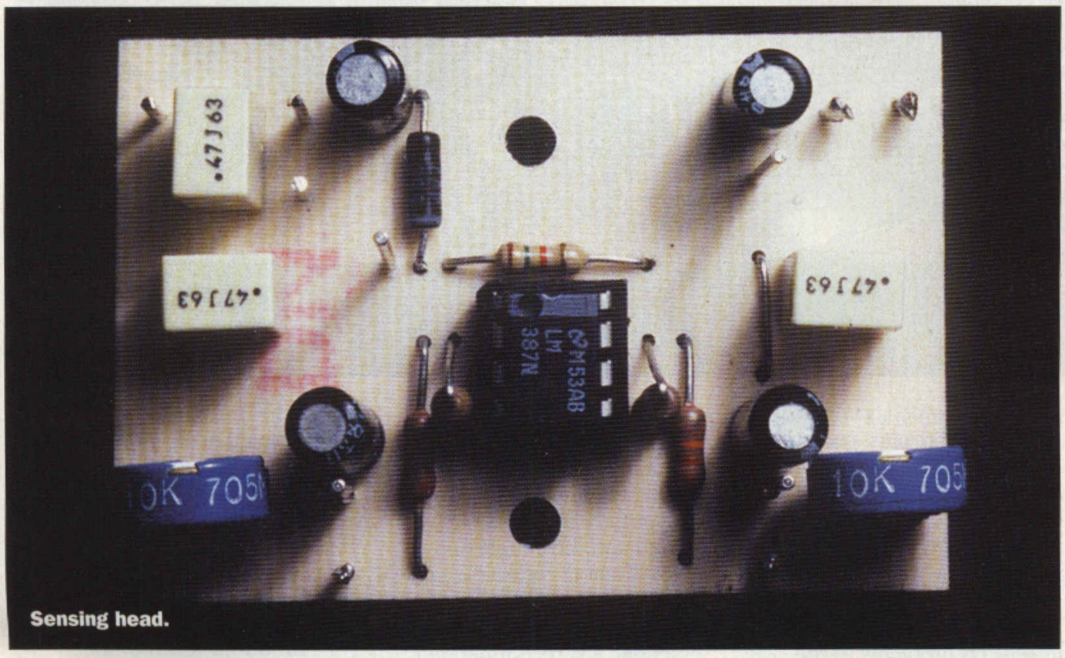


Figure 5b. PCB layout.



Sensing head.

Electrical Assembly

Main PCB:

During development and subsequent testing of the Trainer, a number of 'bugs' were noted and successfully 'swatted!'. The result is that the final PCB and associated component overlay diagram reflect these changes and therefore differ slightly from the prototype version shown in the assembly photographs. The main differences are that some additional links were added and the two status LED limiter resistors were incorporated onto the board. Two other changes were made to the power supply, and consist of the replacement of one of the polyester block capacitors with an electrolytic type and the addition of a 240R resistor. *Note that the numbering of resistors is slightly in error due to this addition, since the reference number R38 has inadvertently been given to it. This should in fact be R43.* The component overlay for the PCB should be referred to periodically during assembly.

PCB Assembly:

For the main PCB fit the components in the following sequence:-

1. All wire link's. Tip – component lead offcuts can be used for most links, and retaining a small film container full of those at 1-4cm long is a worthwhile timesaver.
2. All IC sockets, taking care to fit them with the alignment notches in the correct places
3. All Pre-Set potentiometers
4. The 4 pole DIL Switch, taking care to observe the correct orientation.
5. All electrolytic capacitors NB: take care to ensure correct polarity orientation of all electrolytics, especially that of C30, the power supply reservoir capacitor, and the four tantalum bead capacitors, C17 – C20.
6. All the long test point/signal injection pins.
7. All the other capacitors and the resistors.
8. The LM317T Regulator and heatsink.
9. The L165V Power Op-Amp and heatsink.
10. Plug in the two relays (RLA & RLB).

Check all soldering carefully and correct any errors at this stage. This completes the assembly of the main PCB.

The sensing head PCB is a very simple assembly and, prior to drilling, should be cleaned up and checked in the same manner as the main PCB. All component positions etc, may be determined from overlay diagram.

All holes for the components are drilled 1mm diameter except for the two potentiometers P15 & P16, which are 1.5mm diameter. The two mounting holes are drilled 4BA or 4mm clear.

Fit all components in following order:

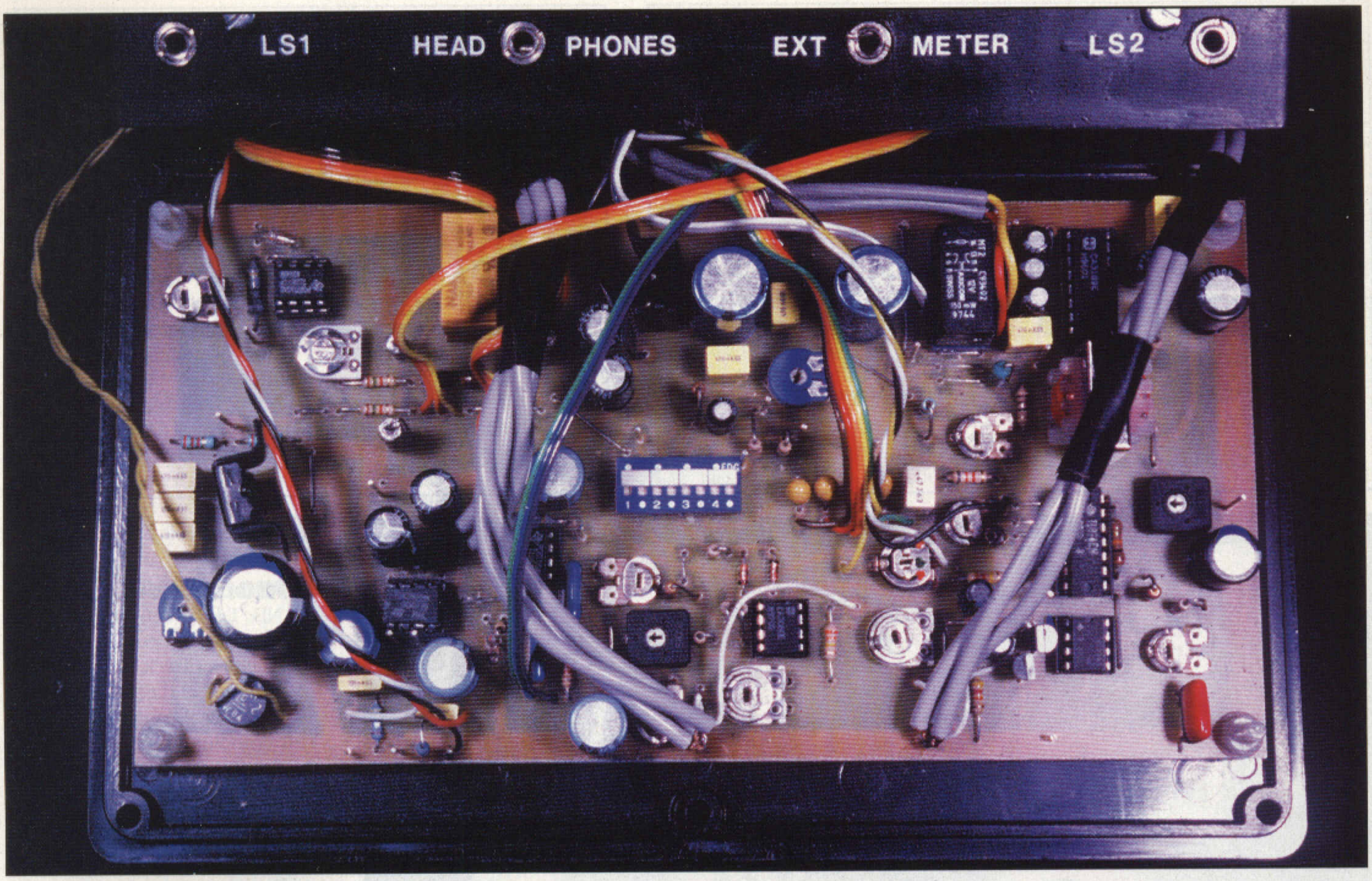
1. IC socket and the test/access pins, but note that on the prototype, test pins TP17 & 18 were omitted. Access to these points is via the IC, pins 4 & 5, respectively).
2. Polyester block capacitors.
3. Resistors, 4.7V Zener diode.
4. The two 10k edge-mounted controls, P15 & P16
5. All the electrolytic capacitors NB: Take great care to fit these with the correct polarity. Check all soldering carefully and correct any errors at this stage.

This completes the assembly of the sensing head PCB.

Wiring Up

The wiring is quite complex and requires care to ensure that certain controls end up connected the correct way round, and that signals are routed to the correct sockets on the front panel. The best approach to wiring up is to start at the box-end of the wiring and to attach all leads to the appropriate control/component, then terminate these on the PCB at the appropriate points. All cables/wires between the controls and the PCB need to be long enough to allow the base to sit on the test bench, with the box lifted off and placed comfortably on the bench, just beyond the top edge of the base. This allows access to all adjustments and observation of the control positions/meter response. It also allows the sensing head to be plugged in directly to the box for some of the testing and setting-up adjustments which will be needed whilst the box is opened up. A suggested length for all cable is therefore 250mm, with another 25mm each end to allow for terminations. (e.g. 300mm overall).

The author decided on point-to-point connection for simplicity, but intending constructor may wish to make up simple cable looms where possible, to ensure a neater job. Reference to the internal photographs will assist in this and a little thought given to preparing cable lengths in advance will allow wires to be



twisted together where possible. The use of short sections of coloured, flat ribbon cable has been incorporated by the author where possible. If any form of cable looming is attempted, then the lengths of certain wires or cables will need to be increased to allow for this. This is left up to the intending constructor.

The wiring for the sensing head is, fortunately, very simple, but note that some of the test/access pins are now used as connection points for the cables and are shortened accordingly. For these short pins, normal Vero-type pins can be used. Most of these short pins are at the inner side of the board nearest the front panel and only two are on the front edge nearest the lid. All cables are 6in long.

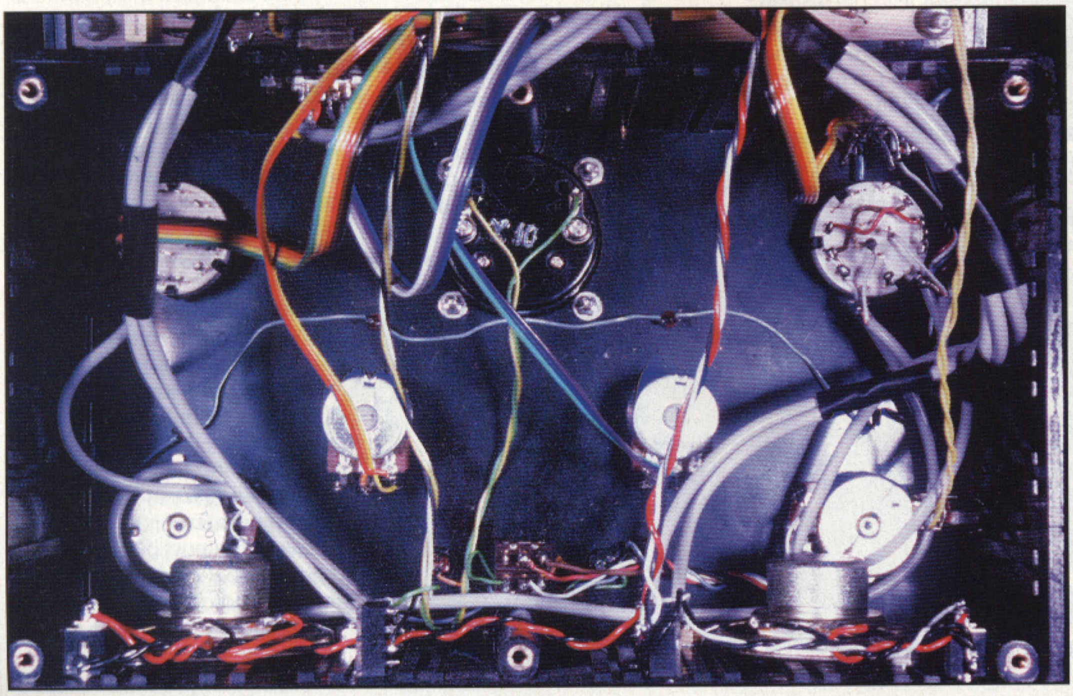
The extension cable should present no problems to the average constructor. However, when connecting the special type of cable used here, it is better to terminate all cable braids on the single tinned copper wire which runs the length of the cable as a guaranteed earth return. This should be done near to the stripped end of the cable sheath and the connection to Pin 9 of the D connector made using only the single tinned copper wire. Although not essential, it is recommended that a length of thin sleeving be placed over this wire to prevent accidental contact with other connections. The rest is a matter of stripping the cores to just the right length and ensuring that all ends do actually end up inside the solder buckets on the D connectors. The wiring schedule for the 'D' Connector is as shown below:

9-way D connector wiring schedule (both ends)

Pin 1 =	Blue core
Pin 2 =	White core
Pin 3 =	Red core
Pin 4 =	Blue screened core
Pin 5 =	Red screened core
Pin 6 =	Yellow core
Pin 7	N/C
Pin 8 =	Separate thick white core (spare link)
Pin 9 =	Braid terminations for screened cores and overall screen. (See note in text on this point)

Notes Relating to Parts List

1. This can be obtained from most camera accessory shops.
2. These can be obtained from Maplin but may have been discontinued, but the larger 21mm type are acceptable, but be careful of alignment.
3. You may have to use the 21mm square type from Maplin, and saves drilling two holes. The bottom edge of the foot should align with the bottom edge of the foot position so that the same spacing parameters apply between the cases of the main and head units.



PROJECT PARTS LIST

RESISTORS (0.6W, Metal film, 1% tolerance unless otherwise)

R1, 2, 3, 42	1k5	M1K5
R4, 33	1k	M1K
R5, 23.	62R (*See text)	M62R
R6, 7, 9, 10, 24.	2k2	M2K2
R8	470R	M470R
R11	10R	M10R
R12, 14, 15, 16, 17.	8k2	M8K2
R18, 26, 30.	10k	M10K
R19	5k6	M5K6
R20	4k7	M4K7
R21, 22	1k2	M1K2
R25, 28	100R	M100R
R29, 38	150k	M150K
R31, 32	220k	M220K
R34	330R	M330R
R35	330k	M330K
R36, 37	4R7	M4R7
R38*	240R (*See Errata List)	M240R
R39, 40	22k	M22K
R38, 41 (Sensing Head)	100k	M100K

PRE-SET POTENTIOMETERS

P1	1k Cermet Horiz	WR40T
P2, 4, 5, 8, 9, 10	10K Sub-Min	UH03D
P3, 12	4k7 Sub-Min	UH02C
P6	22k Sub-Min	UH04E
P7, 11	100k Sub-Min	UH06G
P13, 14	220k Sub-Min	UH07H
P15, 16	10k Sub-Min	UH03D?

POTENTIOMETERS

VR1, 2	4k7 Lin Dual Gang	FW84F
VR3, 4	4k7 Log	FW01B

CAPACITORS

C1, 2	4n7 Poly 1%	BX64U
C3, 4	2n2 Poly 1%	BX60Q
C5, 8, 16, 21, 26, 31, 33, 45, 49, 50	470nF Met Poly	DS80B
C6, 7, 15, 22, 35, 37, 38, 41	47μF Elec 50V Radial	VH33L
C9, 10, 27, 28	470μF Elec 16V Radial	VH46A
C11, 12, 13, 14, 29, 32, 39, 46, 47, 48, 51	10μF Min Elec 16V	VH06G
C17	10μF Tant 16V	WW68Y
C18	4μ7F Tant 16V	WW64U
C19	2μ2F Tant 35V	WW62S
C20	1μF Tant 35V	WW60Q
C23	22nF Polyester 400V	BX72P
C24, 25	68nF Polyester 250V	BX75S
C30	1000μF Elec 35V	WH51F
C34, 45	1μF Min Elec 63V	AT74R
C36, 40	100nF Poly 63V	DT98G
C42	220pF Poly Axial	BX30H

SEMICONDUCTORS

D1, 2, 7	1N4148 Silicon Diode	QL80B
BR1	W005 1A Bridge Rectifier	AQ94C
ZD1	BZY88C4V7 Zener Diode	QH06G
LD1	LED 5mm Green	NP03D
LD2	LED 5mm Red	NP01B
LD 3, 4, 5, 6	LED 3mm Red	NP04E
TR1	BC338	QB69A
TR2	BC327	QB66W
IC1, 6	TL081CN	RA70M
IC2	L165V	UK66W
IC3	CA3189E	WQ20W
IC4	TL074	AV61R
IC5	NE566N	QH68Y
IC7	CA3080E	YH58N
IC8	TDA2822M	UJ38R
IC9	LM317T	AV28F
IC10	LM387N	WQ35Q

CONNECTORS

SK1	2-Off, 9-Way D Connector Socket		RK61R
SK2, 8	3.5mm Stereo Jack Socket		FK20W
SK3, 4, 5, 6	Phono Sockets (Panel mount)		YW06G
SK7, 9	3.5mm Mono Jack Socket		HF82D
PL1	2-Off, 9-Way D Connector Plug		RK60Q
PL2*	2.5mm Co-Axial Power Plug		JK10L
SK2*	2.5mm Power Line Socket		HH62S
	8-pin DIL Skt	6 reqd	BL17T
	16-pin DIL Skt	4 reqd	BL19V
	14-pin DIL Skt	1 reqd	BL18U

SWITCHES & RELAYS

S1	DPDT Sub-Min Panel Switch	FH04E
S2	1P12W Rotary (Set for 1P5W)	FF73Q
S3	2P6W Rotary (Set for 2P3W)	FH43W
S4	2P/2W Sub-Min Slide	FF77J
DS1 – 4	Quad, SPDT DIL Switch	XX29G
RLA, RLB	Miniature 2P c/o 12V DIL Relays	GU36P

TRANSDUCERS

T & R	Matched Pair 40kHz Ultrasonic	HY12N
LS1	Audax Dome Tweeter (25W)	RC75S
MIC1	3-Terminal Electret Insert	CN80B

HARDWARE

ABS Box, Small	MB2	LH21X
ABS Box, Large	MB4	LH23A
Control Knobs	4-Off, NK2 37mm Dia	RX01B
Control Knobs	2-Off, PK2 37mm Dia.	RX02C
Camera Adaptor Bush	1-Off, 3/8in Whit down to 1/4" Whit	(See note 1)
Heat Sink	2-Off, Clip-On T0220	KU50E
4BA Bolts	1Pk, 1/2in Nylon	BF72P
4BA Nuts	1Pk, Flanged, Nylon	BF79L
4BA Bolts	2Pk, Pan head, 1/2in Nickel Plated Brass	BF14Q
4BA Nuts	2Pk, Full nuts, Nickel Plated Brass	BF17T
6BA Bolts	1Pk, 1/2in, C/S Head	LR00A
6BA Nuts	1Pk, Full Nuts	BF18U
M2 Bolts	1Pk, 6mm, Pan Head	JY33L
4BA Washers	1Pk, Plain,	BF21X
4BA Washers	1Pk, Shakeproof,	BF25C
4BA Solder Tags	1Pk, Tinned	BF28F
6BA Washers	1Pk, Plain,	BF22Y
6BA Washers	1Pk, Shakeproof	BF26D
Plastic Feet	2Pk, 17mm Stick-On	(See note 2)
Plastic Feet	2-Off, 16mm Dia X 9mm Deep	(See note 3)
Jubilee Clip	1in Diameter	(See note 4)
Screw Eylet	2-Off, Brass, @8mm	(See note 5)
S-Hook	2-Off, Steel, Medium	(See note 6)
Strap	38mm X 4mm Rubber Band	(See note 7)

MISCELLANEOUS

M1	100-0-100μA Centre Zero Meter	RW98G
T1	LT700 Output Transformer	LB14Q
L1	4m7H R.F. Choke Axial Lead	UK80B
LP1, LP2	12V, 0.96W Min W/End Lamp (See text)	WQ13P
MIC1 Shroud	Soldering Iron Receptacle (9.5mm int. dia.)	(See note 8)
Bail-Lock Mechanism	1 Bail Lock Set	JW94C
Connector Cover	1-Off 9-Way D-Type, Plastic	RK62S
Locking Hood	9-Way D-Type, Metallised Plastic	JB68Y
Jack Posts	1 Set D Connector Jack Post	FP31J
Screened cable	1.5m, miniature, single	XR15R
Screened stereo cable	0.5m, miniature, twin	XR21X
Flat, ribbon cable	0.5m, multi coloured, 10 way	XR06G
Hook-up wire	Thin, coloured, stranded, various colours	(see note 9)
Screened Cable	4 Metres,	XS41U
Plug-in Power Supply	(o/p 12-24V AC/15V-35V DC) 2.5mm Plug	

The miniature tripod used by the author is a Hama, Ministative 2 Type 4027 (See note 10)

The total cost is about £150.

4. This may be omitted if desired and the soldering iron shroud superglued into position. Note it should also be a tight push fit into the panel for added security.
5. Can be obtained from any hardware store selling small fittings.
6. As 5.
7. This is a rubber band.
8. This is a soldering iron receptacle made by Weller. So long as the internal diameter is no larger than 9.5mm, virtually any will do.
9. Thin solid core and stranded core varieties are used and this can be obtained by stripping down surplus multi-core cables.
10. This is a small tripod which is found in many camera shops for approximately £9.50, but any similar type will do.

Acknowlegements

The author wishes to thank two former colleagues, 'John' and also Mr Tony Carter ("TC" to his friends!), for their invaluable assistance in providing PCB production facilities for this project.

Software HINTS & TIPS

by Mike Bedford

Want to create technical documents without having to buy special software? It's easy with Windows 95 and MS Office.

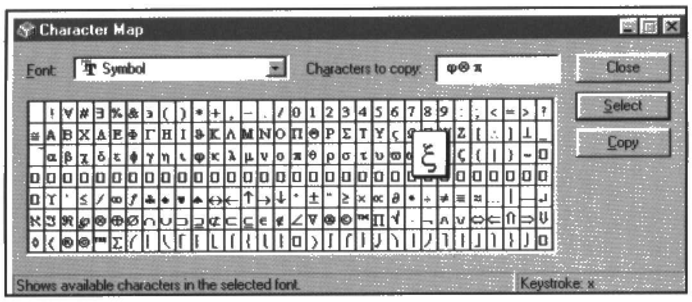
Since this column appears in an electronics magazine as opposed to a computer monthly, there's a good chance that you use your PC for technical purposes. So if you want to write scientific or technical documents, you'll probably need to include Greek letters and symbols, equations and line drawings in your documents. Fortunately, all this can be achieved using the standard facilities of Windows 95 and the Microsoft Office suite as we're about to see.

Symbols

If you do write technical documents, you've probably already figured out how to include many of the more obscure characters which scientists love but which don't appear on your keyboard. However, as with many applications, Windows 95 offers many ways of doing this and you might find some of them to be easier than your current method. Let's run through the options available.

All the Greek letters and most of the symbols needed in scientific literature appear in a character set called Symbols which will almost certainly be installed on your PC. Perhaps the most obvious method of including one of these characters is by selecting Symbol from the Insert menu option of your word processor. A window showing all the characters available in a particular character set will be displayed and, by default, this will be the Symbol character set. To insert a character into a document, simply double click on that character.

If, by any chance, your word processor or other application doesn't have an Insert Symbol option (although MS Word certainly does) then the Character Map accessory offers similar facilities and can be used with any application. This can normally be found by selecting Start > Programs > Accessories > Character Map although, conceivably, you may need to install it from your Windows 95 CD Rom. The Character Map is shown here and you'll notice that it shows all the characters available. Click on a character to see it enlarged and double click on it to transfer that character to the 'Characters to copy' text box. By pressing the 'copy' button, all the characters in this text box are moved to the Windows clipboard and now, of course, they can be inserted into any document by selecting 'paste'.



A Shortcut

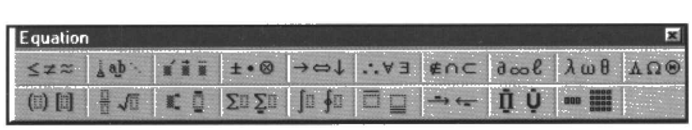
If you're using a lot of Greek characters, you'll find it rather long-winded to insert them using either of the methods we've seen so far. However, you'll find that each of the Greek characters occupies the same position in the Symbol character set as its corresponding English character occupies in the ordinary character sets. This means that, so long as you can remember the equivalents, you can type the appropriate English letter, select it, and then change the font from Times New Roman (or whatever) to Symbol in the normal way. This also is long winded, but it's easy to define a word processor macro to change the font of the previously typed character. So, for example, if you'd assigned that macro to Ctrl-G, the Greek letter alpha would be inserted into the document by typing 'A Ctrl-G'. If you don't know how to do this, using macros is a topic we expect to address in this column in the near future.

Equations

Being able to include weird and wonderful characters is useful but correctly formatted mathematical equations are more than strings of characters. Certainly people make do by representing equations in this way, but Microsoft Office (and other word processors) offer a much better way. Here, we'll look specifically at the equation editing facilities offered by MS Office on the grounds that this is the most commonly used word processor.

The following is how a fraction would be written using the old fashioned in-line method of representing equations: (A+B)/(A-B). Of course, to represent it correctly, the A+B would be immediately above the A-B with a dividing line between them. Then, of course, the brackets are unnecessary. Let's see how the MS Equation editor is used to achieve this.

Select Insert > Object > Create New > Microsoft Equation. The equation editor is displayed and you'll notice that it consists entirely of icons for different elements of equations. A blank equation containing a single 'place holder' will also appear at the cursor position. Click on the icon for fractions and radical templates (second from the left on the bottom row) and a menu of further items will appear. From this menu, select the top left icon which, as you'll see, is for normal fractions with the numerator immediately above the denominator. The blank equation will now change to a horizontal line with blank place holder above it and below it. The cursor will already be in the top place holder so simply type 'A+B'. Finally click in the bottom place holder and type 'A-B' to complete the equation. As soon as you click outside the equation area the equation editor will disappear and you can continue with your normal typing.

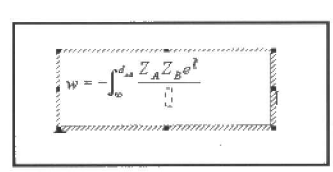


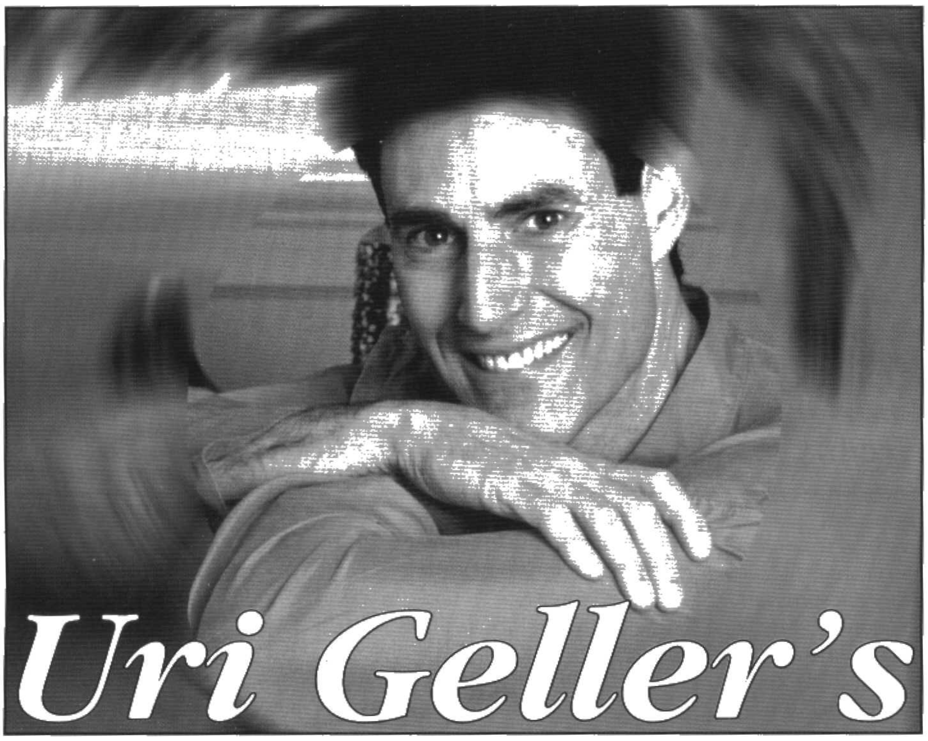
This was a very simple example and the best way to learn more is by experiment. All you need to remember is that you can nest any equation element in the place holders created by a higher level equation element. The following portion of screen shot should help to clarify this concept and show how quite complicated equations can be built up quickly and intuitively. Here, the equation is partially complete and two empty place holders are visible.

Line Drawings

Line drawings are something else you'll probably need to include in technical documents. If you're doing a lot of technical illustrations, then you'll probably have dedicated software such as CorelDraw or something more specialised like an electronic schematic drafting package. However, if you only need to produce the occasional line diagram, you can use the facility which comes as part of the MS Office suite. We don't have space to give a full tutorial on this applet but if we point out its presence, a few minutes worth of practice will soon get you up to speed.

From Word, select Insert > Object > Create New > Microsoft Drawing. From the Microsoft Drawing window which appears, you can build up your illustration using various elements such as lines, rectangles, circles and text. And unlike the MS Paint utility, this is a vector oriented utility so you can subsequently use the pointer tool (the arrow icon) to select and modify each part of your drawing.





Uri Geller's EXTENDED REALITY

Group Consciousness

Do you remember what you were doing on the 3rd October 1995 at six o'clock in the evening (GMT)? NO? Then you can't have been one of the half billion people all over the world who were glued to their television screens waiting for the verdict in one of the most controversial murder trials of the century – that of footballer 0.J. Simpson

One man who certainly was watching it was a very bright scientist from the Consciousness Research Laboratory at the University of Nevada named Dean Radin. He was also keeping an eye on his three random number generators which had been programmed to generate several hundred random bits every few seconds, which showed up on the screens as a more or less straight line, indicating that roughly equal number of 0s and 1s were being generated.

On the other side of the country, at Princeton University, Dr Roger Nelson was doing the same thing with his RNG, and so was Professor Dick Bierman at the University of Amsterdam in the Netherlands. The five machines had been running for an hour before the broadcast went on air at 5 p.m., the squiggly lines at the bottom of their screens showing that all five machines were doing what they were designed to do and producing a balanced output of noughts and ones.

About twenty minutes before the pre-shows began, the line began to rise sharply upwards, falling back to normal again until shortly before 6 p.m., when the verdict was expected and the live broadcast began. When the court clerk read out the 'not guilty' verdict a couple of minutes later, all five RNG machines simultaneously reached their highest points – at the exact moment the verdict was announced.

Those half billion television viewers around the world had (without knowing it, of course) just taken part in one of a fascinating series of experiments that should make us all think again about such concepts as collective consciousness, group minds and holistic universes. At the very least, there should be no more argument about whether the human mind can have a direct influence on a machine. What Radin has shown is that when large numbers of people are in an intensely emotional or excited state, they are actually helping to create order out of chaos.

Radin obtained similar results at the Academy Awards ceremony in 1995, when his RNG display peaked sharply as the winners were named. So it did in the 1996 ceremony, and at the Superbowl game of that year. Then, in July, Radin ran an experiment with the help of no less than three billion viewers, who were tuned in to watch the opening ceremony of the Olympic Games. This lasted nearly five hours, and he noticed that the level of order in the system not only rose steadily soon after the opening, but stayed high until the end of the broadcast. He reckoned that this was because there was a high level of excitement throughout the show, unlike the murder trial or Oscar ceremonies where there were brief peaks of emotion only.

The implications of these experiments – which cost almost nothing and can be repeated easily by anybody – are mind-boggling. They have shown that mind and matter really can and do interact, and not just when I am bending a spoon! They have also shown that when a large number of people feel the same way at any given moment, their thoughts can combine into one huge thought form – positive or negative. Radin reckons that this might explain how mass movements get together and spread out, whether they are peaceful like those of Gandhi or Martin Luther King, or hostile like the various fundamentalist religious groups whose only aim seems to be to spread death and destruction.

Something like this, I suspect, lay behind the sudden collapse of communism and the knocking down of the Berlin wall, also maybe the arrival of real peace in Northern Ireland.

You can find full details of Radin's research and equipment in his book *The Conscious Universe* (HarperEdge, U.S.A.). It hasn't been published in the U.K. yet, but a good bookseller can get you a copy of the American edition. It is subtitled 'The Scientific Truth of Psychic Phenomena', and it has already made quite an impact on Radin's fellow scientists.

Rupert Sneldrake, whose work with psychic dogs I have described before, says: "Radin makes the most powerful case for the reality of parapsychological phenomena that I have yet encountered." He adds that, "this book shows that we are at a turning point in our scientific understanding of our minds and of nature". Nobel Prize winner Professor Brian Josephson is equally impressed. "Cutting perceptively through the spurious arguments frequently made by sceptics, Radin shows the evidence for paranormal existence is overwhelming."

I would agree with all of that, and I'm glad that Radin makes the point that the really hard evidence for psychic powers has come not from individuals like me, but from a large number of ordinary people including TV viewers who don't even know they are taking part in any experiments! All the same, I can claim some of the credit for showing people all over the world that they can make things happen by using their minds properly, not just for bending spoons and starting broken clocks, but as I show in *Uri Geller's Little Book of Mind Power* (Robson Books) for transforming themselves and society.

Radin may have been joking when he wrote that maybe one day we will be able to open garage doors by mind power. Or he may have been serious – just after the first draft of this column was finished, there was an item on BBC radio news about an American scientist who has invented a computer for the disabled which works on you've guessed it – mind power.

LED Graph CIRCUITS

Ray Marston presents a variety of practical LED dot-graph and bar-graph analogue-value display circuits.

Figure 1. Bar-graph indication of (a) 7V and (b) 4V on a 10V 10-LED scale.

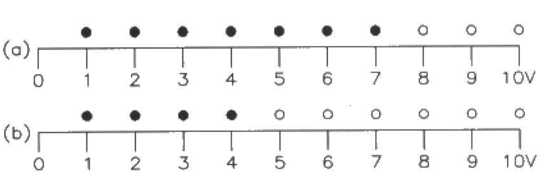
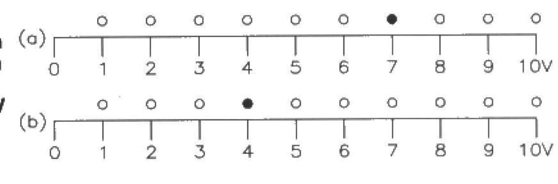


Figure 2. Dot-graph indication of (a) 7V and (b) 4V on a 10V 10-LED scale.



One of the most popular types of multi-LED indicator circuit is the so called analogue-value indicator or 'graph' display, which is designed to drive a chain of linearly-spaced LEDs in such a way that the length of chain that is illuminated is proportional to the analogue value of a voltage applied to the input of the LED-driver circuit, e.g., so that the circuit acts like an analogue voltmeter.

Practical graph circuits may be designed to generate either a bar-graph or a dot-graph display. Figure 1 illustrates the bar-graph principle, and shows a line of ten LEDs used to represent a linear-scale 0-10V meter that is indicating (a) 7V or (b) 4V; the input voltage value is indicated by the total number of LEDs that are illuminated. Figure 2 shows the same meter operating in the dot-graph mode; the input voltage value is indicated by the relative position of a single illuminated LED. In reality, the '0' position is often indicated on these scales by a separate LED that is permanently active whenever the display is in use

A number of special ICs are available for operating general-purpose LED analogue-value display systems. For many years the best known ICs of this type were the U237 (etc.) family from AEG, the UAA170 (etc.) family from Siemens, and the LM3914 (etc.) family from National Semiconductors, but the first two of these families have now ceased production, and only the LM3914 family remains. The LM3914 family are popular and versatile ICs that can each directly drive up to ten LEDs (but can easily be cascaded to drive larger numbers of LEDs) and can drive them in either bar or dot mode.

IC-driven bar-graph displays make inexpensive and in some ways superior alternatives to analogue-indicating moving-coil

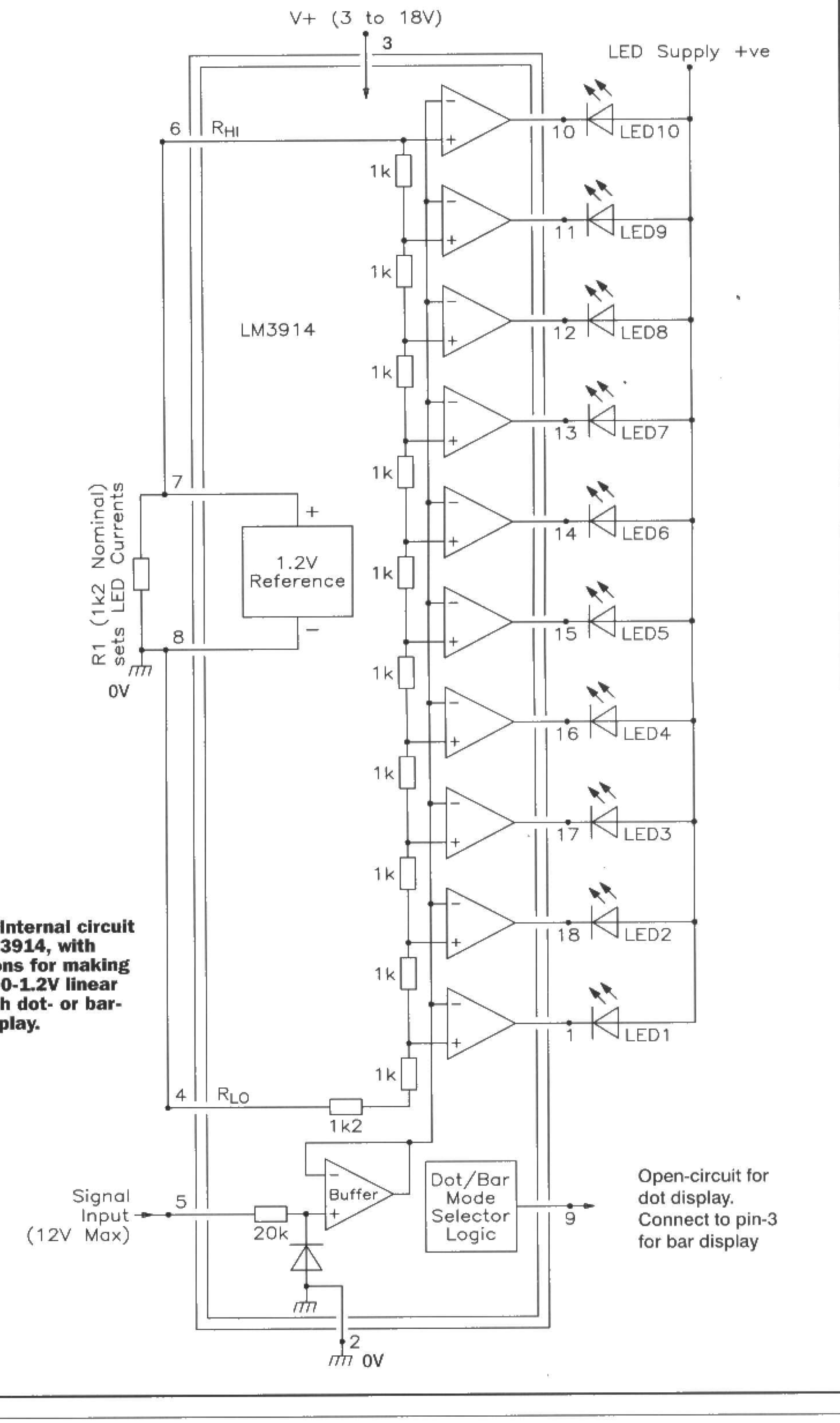


Figure 3. Internal circuit of the LM3914, with connections for making a 10-LED 0-1.2V linear meter with dot- or bar-graph display.

LED Number	Typical threshold-point values, for 10V f.s.d.					
	LM3914	LM3915		LM3916		
	V	V	dB	V	dB	Vu
1	1.00	0.447	-27	0.708	-23	-20
2	2.00	0.631	-24	2.239	-13	-10
3	3.00	0.891	-21	3.162	-10	-7
4	4.00	1.259	-18	3.981	-8	-5
5	5.00	1.778	-15	5.012	-6	-3
6	6.00	2.512	-12	6.310	-4	-1
7	7.00	3.548	-9	7.079	-3	0
8	8.00	5.012	-6	7.943	-2	+1
9	9.00	7.079	-3	8.913	-1	+2
10	10.00	10.000	0	10.000	0	+3

Figure 4. Threshold-point values of the LM3914/15/16 range of ICs when designed to drive ten LEDs at a full-scale sensitivity of 10V.

meters. They are immune to 'sticking' problems, are fast acting, and are unaffected by vibration or by physical attitude. Their scales can easily be given any desired shape. In a given display, individual LED colours can be mixed to emphasise particular sections of the display, and 'over-range' detectors can easily be activated from the driver ICs and used to sound an alarm and/or flash the entire display under the over-range condition.

LED 'graph' displays have better linearity than conventional moving-coil meters, typical linear accuracy being 0.5%. The scale's resolution depends on the number of LEDs used; a 10-LED display gives adequate resolution for many practical purposes. A wide variety of multi-LED LM3914-based graph display circuits are shown in this article.

LM3914-Family Basics

The LM3914 family of dot-/bar-graph driver ICs are manufactured by National Semiconductors. They are moderately complex but highly versatile devices, housed in 18-pin DIL packages and each capable of directly driving up to ten LEDs in either the dot or the bar mode. The family comprises three devices, these being the LM3914, the LM3915, and the LM3916; they all use the same basic internal circuitry (see Figure 3), but differ in the style of scaling of the LED-driving output circuitry, as shown in Figure 4.

Thus, the LM3914 is a linearly-scaled unit, specifically intended for use in LED voltmeter applications in which the number of illuminated LEDs gives a direct indication of the value of an input voltage (or of some parameter that is represented by a proportional voltage). The LM3915, on the other hand, has a log-scaled output designed to span -27dB to 0dB in ten -3dB steps, and is specifically designed for use in power-indicating applications, etc. Finally, the LM3916 has a semi-log scale that spans 23dB, and is specifically designed for use in VU meter applications.

All three devices of the LM3914 family use the same basic internal circuitry, and Figure 3 shows the specific internal circuit of the linear-scaled LM3914, together with the connections for making it act as a simple 10-LED 0-1.2V meter. The IC contains ten voltage comparators, each with its non-inverting terminal taken to a specific tap on a floating precision multi-stage potential divider and with all inverting terminals wired in parallel and accessible via input pin-5 and a built-in unity gain buffer amplifier. The output of each comparator is externally available, and can sink up to 30mA; the sink currents are internally limited, and can be externally pre-set via a single resistor (R1).

The IC also contains a floating 1.2V reference source between pins 7 and 8. In Figure 3 the reference is shown externally connected to the internal potential divider (pins 4 and 6). Note that pins 8 and 4 are shown grounded, so in this case the bottom of the divider is at zero volts and the top is at 1.2V. The IC also contains a logic network that can be externally set (via pin-9) to give either a dot or a bar display from the outputs of the ten comparators. The IC operates as follows.

Assume that the IC logic is set for bar-mode operation, and that the 1.2V reference is applied across the internal 10-stage divider as shown. Thus, 0.12V is applied to the inverting or reference input of the lower comparator, 0.24V to the next, 0.36V to the next, and so on. If a slowly rising input voltage is now applied to pin-5 of the IC the following sequence of

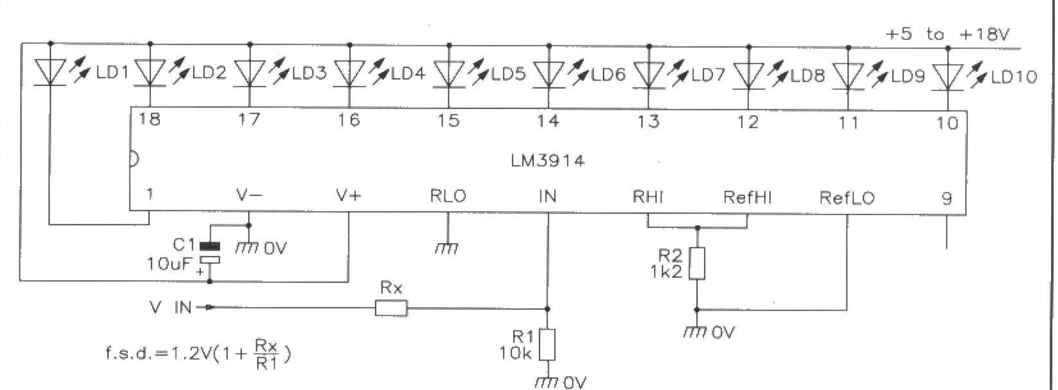


Figure 5. 1.2V to 1000V f.s.d. dot-mode voltmeter.

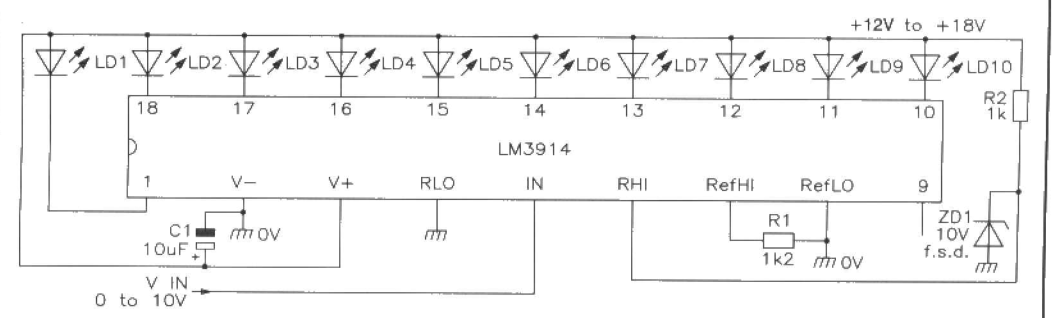


Figure 6. 10V f.s.d. meter using an external reference.

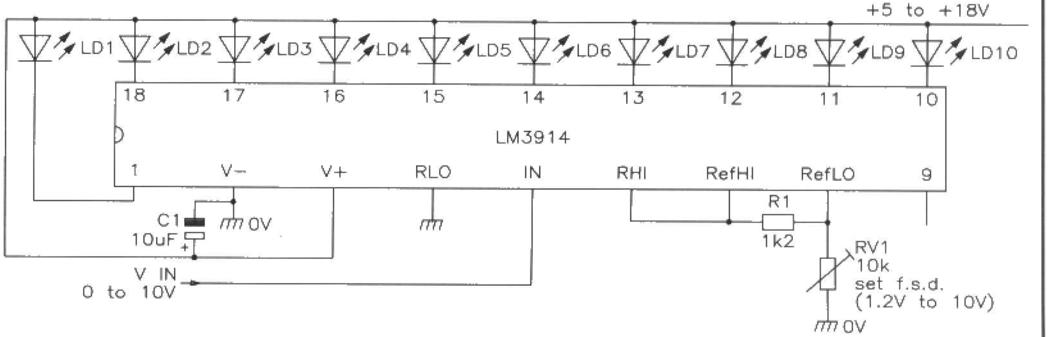


Figure 7. An alternative variable-range (1.2V to 10V) dot-mode voltmeter.

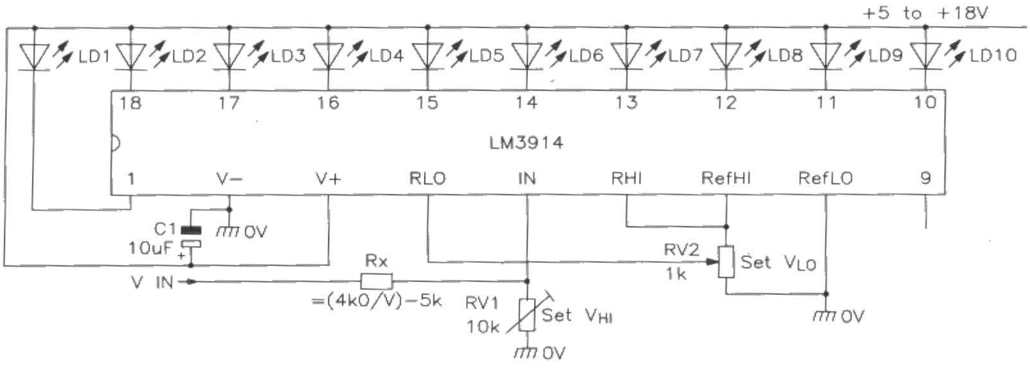


Figure 8. Expanded-scale (10V – 15V, etc) dot-mode voltmeter.

actions takes place.

When the input voltage is zero the outputs of all ten comparators are disabled and all LEDs are off. When the input voltage reaches the 0.12V reference value of the first comparator its output conducts and turns LED1 on. When the input reaches the 0.24V reference value of the second comparator its output also conducts and turns on LED2, so at this stage LEDs 1 and 2 are both on. As the input voltage is further increased progressively more and more comparators and LEDs are turned on until eventually, when the input rises to 1.2V, the last comparator and LED10 turn on, at which point all LEDs are on.

A similar kind of action is obtained when the LM3914 logic is set for dot mode operation, except that only one LED is on at any given time; at zero volts no LEDs are on, and at 1.2V and greater only LED10 is on.

Some Finer Details

In Figure 3, R1 is shown connected between pins 7 and 8 (the output of the 1.2V reference), and determines the ON currents of the LEDs. The ON current of each LED is roughly ten times the output current of the 1.2V source, which can supply up to 3mA and thus enables LED currents of up to 30mA to be set via R1. If, for example, a total resistance of 1k2 (equal to the paralleled values of R1 and the 10k of the ICs internal potential divider) is placed across pins 7 and 8 the 1.2V source will pass 1mA and each LED will pass 10mA in the ON mode.

Note from the above that the IC can pass total currents up to 300mA when used in the bar mode with all ten LEDs on. The IC has a maximum power rating of only 660mW, however, so there is a danger of exceeding this rating when the IC is used in the bar mode. In practice, the IC can be powered from DC supplies in the range 3 to 25 volts, and the LEDs can use the same supply as the IC or can be independently powered; this latter option can be used to keep the IC power dissipation at a minimal level.

The internal 10-stage potential divider of the IC is floating, with both ends externally available for maximum versatility, and can be powered from either the internal reference or from an external source or sources. If, for example, the top of the chain is connected to a 10V source, the IC will function as a 0-10V meter if the low end of the chain is grounded, or as a restricted-range 5-10V meter if the low end of the chain is tied to a 5V source. The only constraint on using the divider is that its voltage must not be greater than 2V less than the ICs supply voltage (which is limited to 25V maximum). The input (pin-5) to the IC is fully protected against overload voltages up to plus or minus 35V.

The internal voltage reference of the IC produces a nominal output of 1.28V (limits are 1.2V to 1.34V), but can be

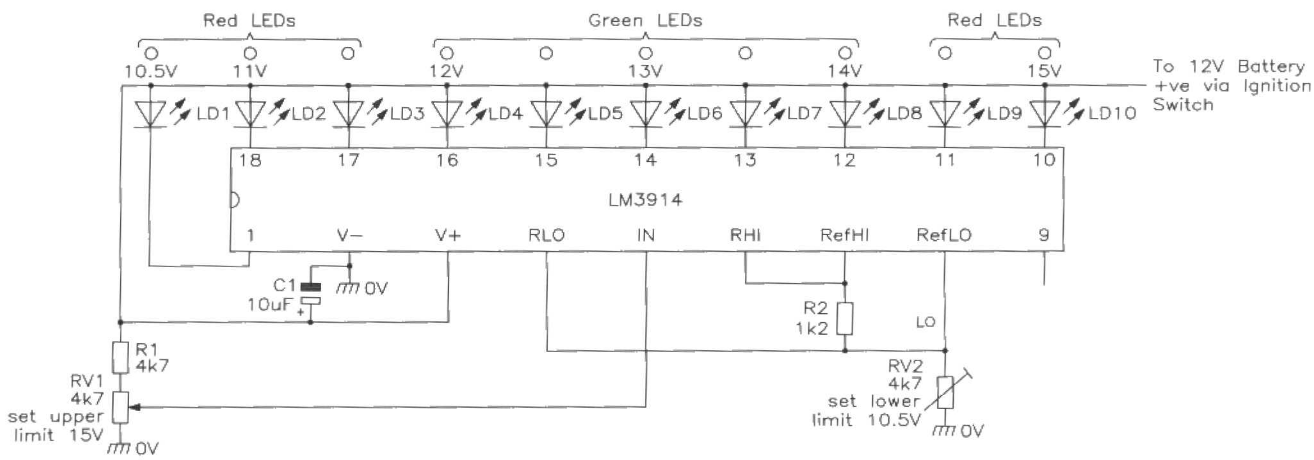


Figure 9. Expanded-scale dot-mode vehicle voltmeter.

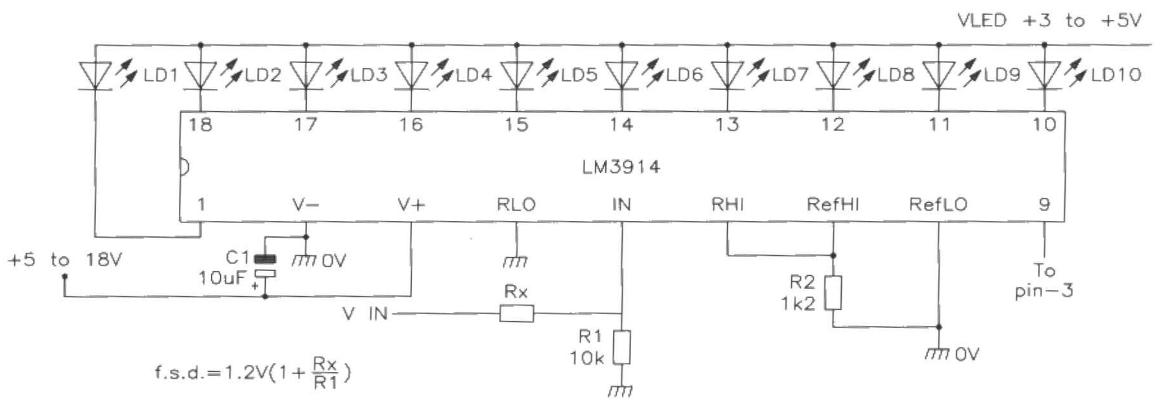
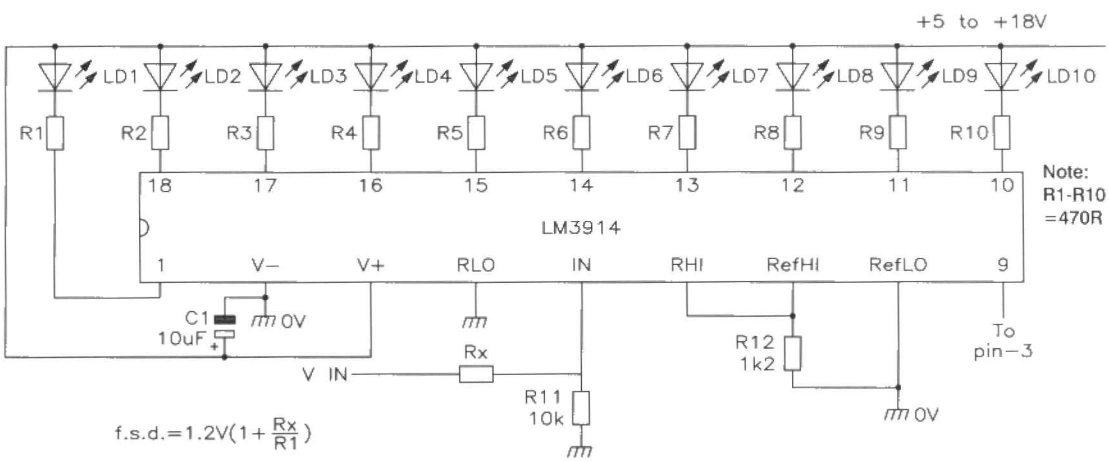


Figure 10. Bar-display voltmeter with separate LED supply.

Figure 11. Bar-display voltmeter with common LED/IC supply.



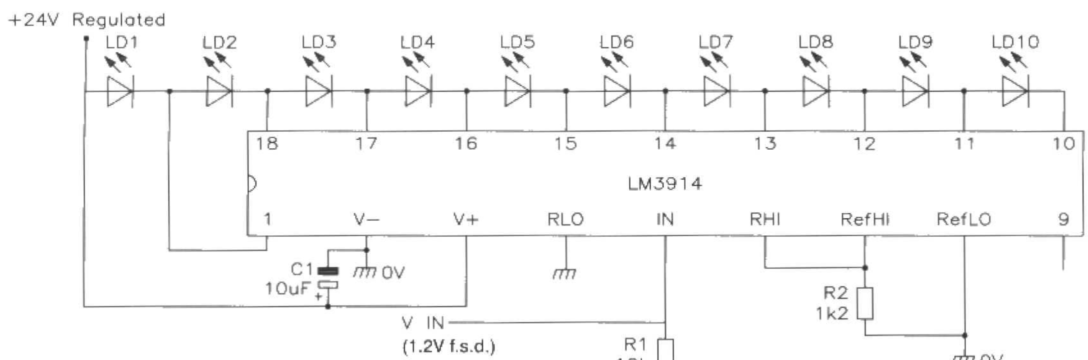


Figure 12. Method of obtaining a bar display with dot-mode operation and minimal current consumption.

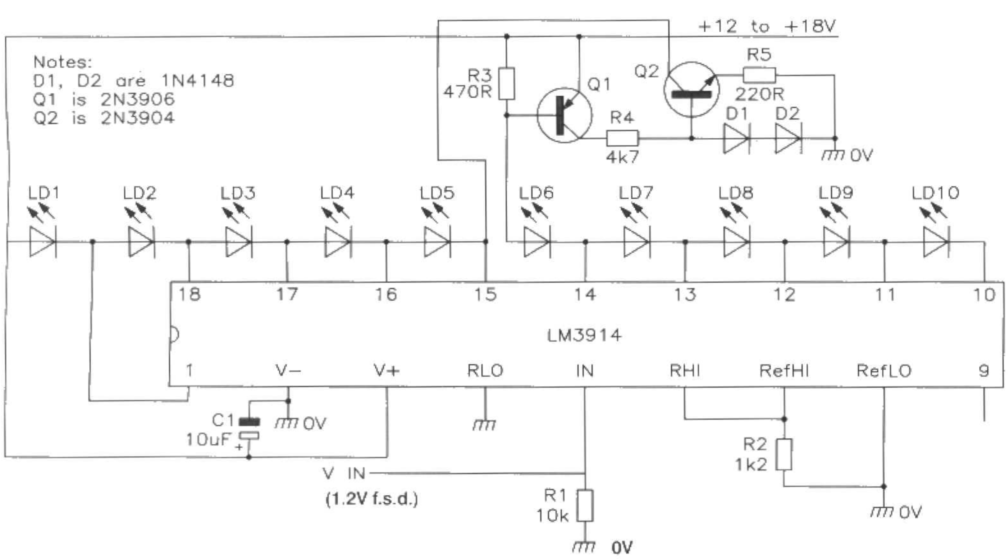


Figure 13. Modification of the Figure 12 circuit, for operation from unregulated 12V to 18V supplies.

externally programmed to produce effective reference values up to 12V (as show later).

The IC can be made to give a bar display by wiring pin-9 directly to pin-3 (positive-supply), or – if only one IC is used – can be made to give a dot display by leaving pin-9 open circuit or by pulling it at least 200mV below the pin-3 voltage value. If two or more ICs are cascaded to drive 20 or more LEDs in the dot mode, pin-9 must (except in the case of the final IC in the chain) be wired to pin-1 of the following IC, and a 20k resistor must be wired between pin-11 and the LED-powering positive supply rail.

Finally, note that the major difference between the three members of the LM3914 family of ICs lays in the values of resistance used in the internal 10-stage potential divider. In the LM3914 all resistors in the chain have equal values, and thus produce a linear display of ten equal steps. In the LM3915 the resistors are logarithmically weighted, and thus produce a log display that spans -27dB to 0dB in ten -3dB steps. In the LM3916 the resistors are weighted in semi-log fashion and produce a display that is specifically suited to VU-meter applications. Let's now move on and look at some practical applications of this series of devices, paying particular attention to the linear LM3914 IC.

Dot-Mode Voltmeters

Figures 5 to 9 show various ways of using the LM3914 IC to make 10-LED dot-mode voltmeters with a variety of full-scale deflection (f.s.d) sensitivities. Note in all these circuits that pin-9 is left open-circuit, to give dot-mode operation, and that a 10μF capacitor is wired directly between pins 2 and 3 to enhance circuit stability.

Figure 5 shows the connections for making a variable-range (1.2V to 1000V f.s.d) voltmeter. The low ends of the internal reference and divider are grounded and their top ends are joined together, so the meter has a basic full-scale sensitivity of 1.2V, but variable ranging is provided by the Rx-R1 potential divider at the input of the circuit. Thus, when Rx is zero, f.s.d is 1.2V, but when Rx is 90k the f.s.d is 12V. Resistor R2 is wired across the internal reference and sets the ON currents of the LEDs at about 10mA.

Figure 6 shows how to make a fixed-range 0-10V meter, using an external 10V Zener (connected to the top of the internal divider) to provide a reference voltage. The supply voltage to this circuit must be at least two volts greater than the zener

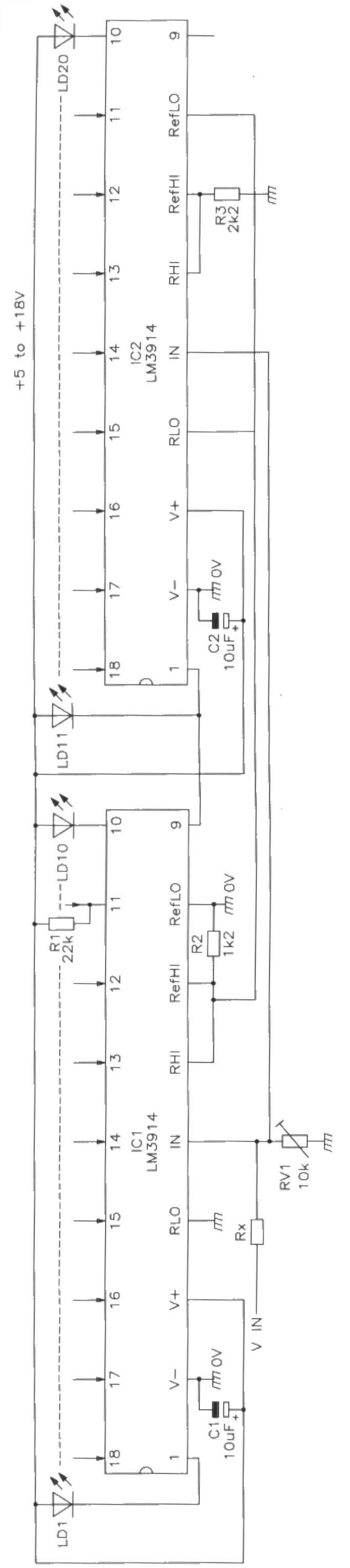


Figure 14. Dot-mode 20-LED voltmeter (f.s.d = 2.4V when Rx = 0).

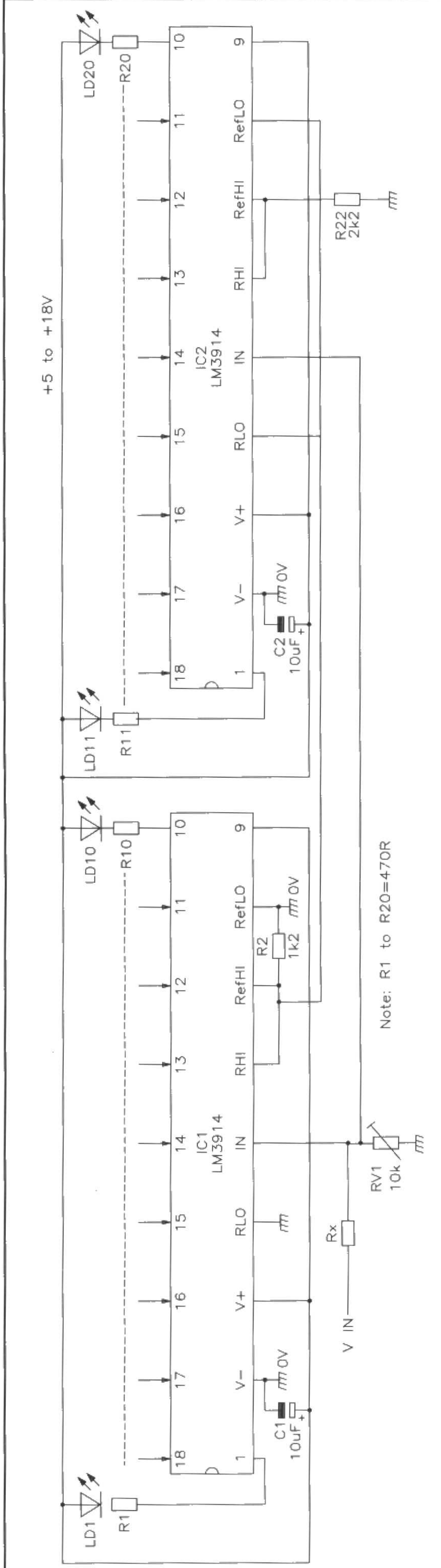


Figure 15. Bar-mode 20-LED voltmeter (f.s.d = 2.4V when Rx = 0).

greater than the zener reference voltage.

Figure 7 shows how the internal reference of the IC can be made to effectively provide a variable voltage, enabling the meter f.s.d value to be set anywhere in the range 1.2V to 10V. In this case the 1mA current (determined by R1) of the floating 1.2V internal reference flows to ground via RV1, and the resulting RV1-voltage raises the reference pins (pins 7 and 8) above zero. If, for example, RV1 is set to 2k4, pin-8 will be at 2.4V and pin-7 at 3.6V. RV1 thus enables the pin-7 voltage (connected to the top of the internal divider) to be varied from 1.2V to about 10V, and thus sets the f.s.d value of the meter within these values. Note that the circuit's supply voltage must be at least 2V greater than the desired f.s.d. voltage value.

Figure 8 shows the connections for making an expanded-scale meter that, for example, reads voltages in the range 10 to 15V. RV2 sets the LED current at about 12mA, but also enables a reference value in the range 0-1.2V to be set on the low (pin-4) end of the internal divider. Thus, if RV2 is set to apply 0.8V to pin-4 the basic meter will read voltages in the range 0.8 to 1.2V only. By fitting potential divider Rx-RV1 to the input of the circuit this range can be amplified to (say) 10-15V, or whatever range is desired.

Finally, Figure 9 shows an expanded scale dot-mode voltmeter that is specifically designed to indicate the value of a vehicle's battery (12V nominal). In this case R2-RV2 are effectively set to give a basic range of 2.4 to 3.6V, but the input to the circuit is derived from the positive supply rail via the R1-RV1 potential divider, and the indicated volts reading thus corresponds to a pre-set multiple of the basic range value. As shown in the diagram, red and green LEDs can be used in the display, arranged so that green LEDs illuminate when the voltage is in the 'safe' range 12 to 14V.

To calibrate the above circuit, first set the supply to 15V and adjust RV1 so that LED-10 just turns on. Reduce the supply to 10V and adjust RV2 so that LED-1 just turns on. Recheck the settings of RV1 and RV2. The calibration is then complete and the unit can be installed in the vehicle by taking the '0' volt lead to chassis and the '+12V' lead to the vehicle's battery via the ignition switch.

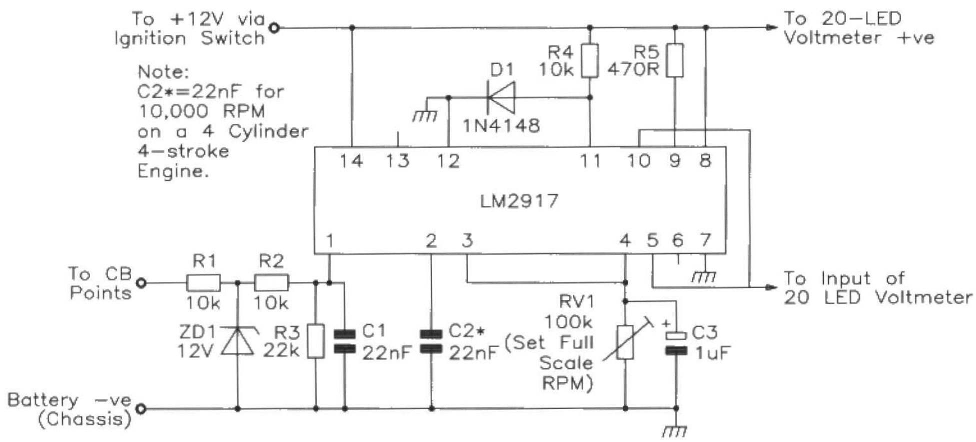


Figure 16. Vehicle tacho conversion circuit for use with a 20-LED voltmeter.

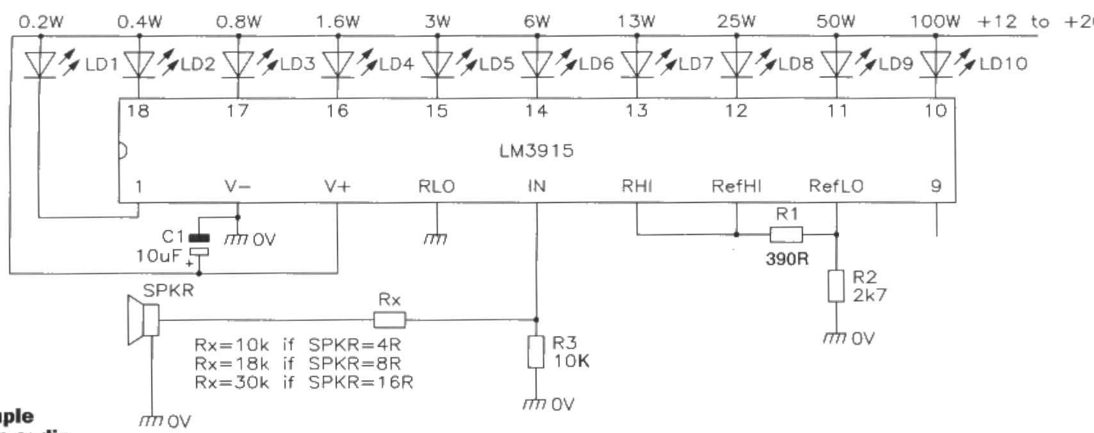


Figure 17. Simple speaker-driven audio power meter.

Bar-Mode Voltmeters

The dot-mode circuits of Figures 5 to 9 can be made to give bar-mode operation by simply connecting pin-9 to pin-3, rather than to pin-11. When using the bar mode, however, it must be remembered that the IC's power rating must not be exceeded by allowing excessive output-terminal voltages to be developed when all ten LEDs are on. LEDs drop roughly 2V when they are conducting, so one way around this problem is to power the LEDs from their own low-voltage (3 to 5V) supply, as shown in Figure 10.

An alternative solution is to power the IC and the LEDs from the same supply, but to wire a current-limiting resistor in series with each LED, as shown in Figure 11, so that the IC's output terminal saturates when the LEDs are on.

Figure 12 shows another way of obtaining a bar display without excessive power dissipation. Here, the LEDs are all wired in series, but with each one connected to an individual output of the IC, and the IC is wired for dot-mode operation. Thus, when (for example) LED-5 is on it draws its current via LEDs 1 to 4, so all five LEDs are on and the total LED current equals that of a single LED, and total power dissipation is quite low. The LED supply to this circuit must be greater than the sum of all LED volt-drops when all LEDs are on, but must be within the voltage limits of the IC; a regulated 24V supply is thus needed.

Figure 13 shows a very useful modification which enables the above circuit to be powered from unregulated supplies within the 12 to 18V range. In this case the LEDs are split into two chains, and the transistors are used to switch on the lower (LEDs 1 to 5) chain when the upper chain is active; the maximum total LED current equals twice the current of a single LED.

20-LED Voltmeter

Figure 14 shows how two LM3914 ICs can be inter-connected to make a 20-LED dot-mode voltmeter. Here, the input terminals of the two ICs are wired in parallel, but IC1 is configured so that it reads 0 to 1.2V, and IC2 is configured so that it reads 1.2 to 2.4V. In the latter case the low end of the IC2 potential divider is coupled to the 1.2V reference of IC1,

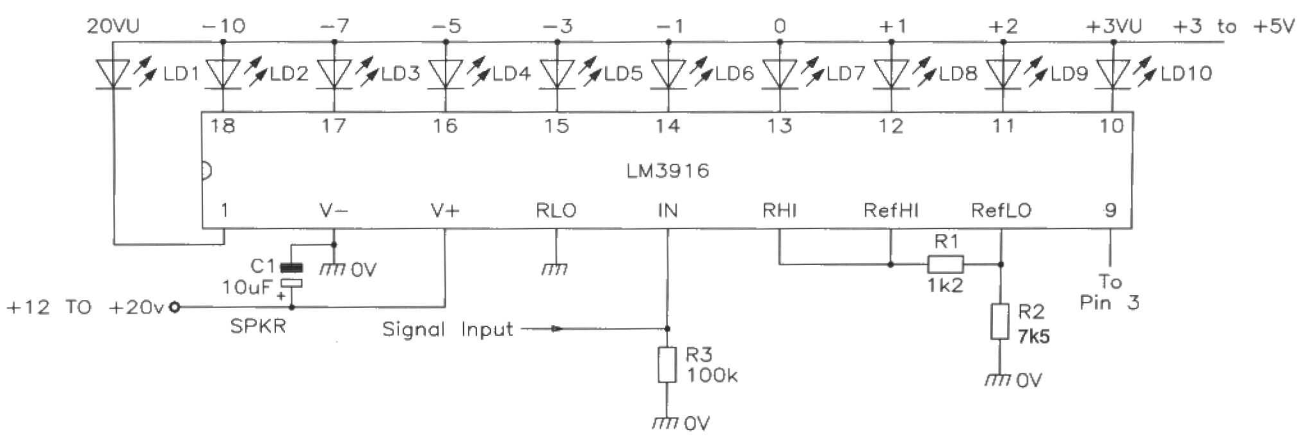


Figure 18. Basic bar-mode VU-meter circuit.

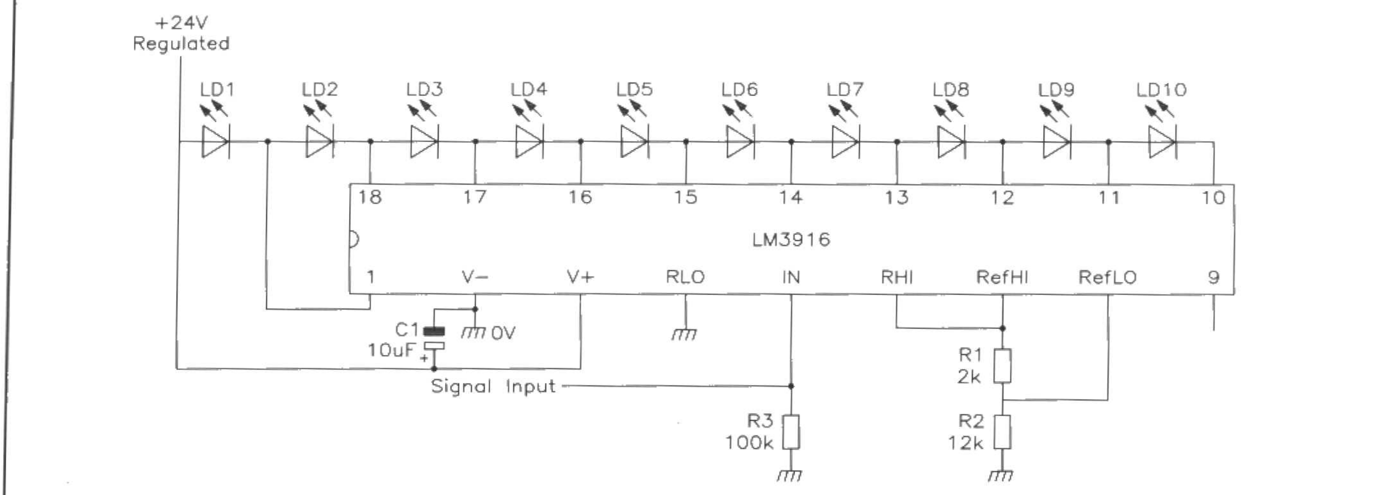


Figure 19. This basic VU-meter circuit gives a bar-type display, with a dot-type current drain.

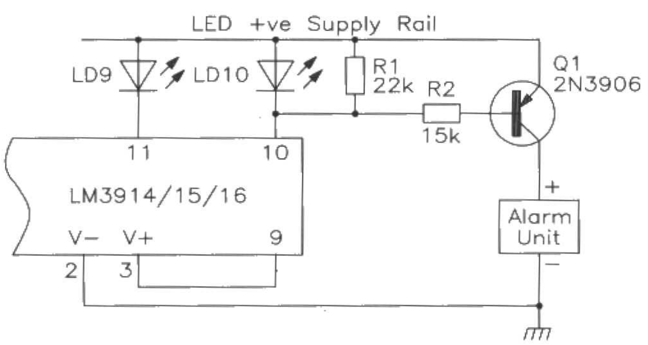


Figure 20. An over-range alarm-driver circuit, for use with bar-type displays.

and the top end of the divider is taken to the top of the 1.2V reference of IC2, which is raised 1.2V above that of IC1.

The 20-LED Figure 14 circuit is wired for dot-mode operation, and in this case pin-9 of IC1 is wired to pin-1 of IC2, pin-9 of IC2 is open circuit, and a 22k resistor is wired in parallel with LED-9 of IC1.

Figure 15 shows the connections for making a 20-LED bar-mode voltmeter. The connections are similar to those of Figure 14, except that pin-9 is taken to pin-3 on each IC, and a 470R current-limiting resistor is wired in series with each LED to reduce the power dissipation of the ICs.

To conclude this look at LM3914 circuits, Figure 16 shows a simple frequency-to-voltage converter that can be used to convert either of the Figure 14 or 15 circuits into 20-LED tachometers (RPM-meters). This converter should be interposed between the vehicle's contact-breaker points and the input of the voltmeter circuit. In Figure 16, the C2 value of 22nF is the optimum value for a full-scale range of 10,000rpm on a 4-cylinder 4-stroke engine. For substantially lower full-scale RPM values, the C2 value may have to be increased: the value may have to be reduced on vehicles with six or more cylinders.

LM3915/LM3916 Circuits

The LM3915 'log' and LM3916 'semi-log' ICs operate in the same basic way as the LM3914, and can in fact be directly used in most of the circuits shown in Figures 5 to 15. In most practical applications, however, these particular ICs are used to indicate the value of an ac input signal, and the simplest way of achieving such a display is to connect the ac signal directly or via an attenuator to the pin-5 input terminal of the IC, as shown in Figure 17. The IC responds only to the positive halves of such input signals, and the number of illuminated LEDs is thus proportional to the instantaneous peak value of the input signal.

The Figure 17 circuit is that of a simple LM3915-based audio power meter that is used to indicate instantaneous output voltage values from an external loudspeaker. Pin-9 is left open-circuit to give dot-mode operation, and R1 has a value of 390R to give a LED current of about 30mA, thus giving a clear indication of brief instantaneous voltage levels. The meter gives audio power indication over the range 200mW to 100W.

Figure 18 shows the basic way of using the LM3916 IC as a VU-meter with a full-scale sensitivity of 10V dc. The circuit is shown connected for bar-mode operation, using separate supply voltages for the LED display and for the actual IC, and with the component values shown gives a current drive of 10mA to each active LED. If preferred, the IC can be used to give dot-mode operation, using a common 12V to 20V supply for the LEDs and the IC, by leaving pin-3 open circuit and changing the R1-R2 values to 390R-2k4, thus giving 30mA of drive to the active LEDs.

Figure 19 shows an alternative way of using the LM3916 as a VU-meter with a bar-type display. In this case the IC is used in the same way as the basic Figure 12 low-current-consumption circuit, with pin-9 left open circuit. The IC actually operates in the dot mode, but with the LEDs wired in series across the display-driving pins so that a bar-type display is obtained, with all active LED currents flowing through the currently-active driving pin. With the component values shown, this circuit has a full-scale sensitivity of 10V and provides a LED-drive current of 16mA.

The basic Figure 17 to 19 LM3915 and LM3916 circuits are shown being driven directly from ac signal inputs, and this technique is adequate in many applications. In cases where the display is required to relate specifically to peak, rms, or average values of ac input voltage, this can be achieved by interposing a suitable ac/dc converter circuit between the ac signal and the pin-5 input terminal of the LM3915 or LM3916 IC. Many suitable circuits are published in op-amp application manuals and circuit reference books and encyclopaedias, etc.

An Over-Range Alarm-Driver Circuit

To conclude this article, Figure 20 shows a simple way of fitting an alarm-driving over-range switch to a bar-type LM3914-series LED-driving indicator circuit. Here, pnp transistor Q1 is wired between the LED positive supply rail and the 0V rail, with its base connected to the IC's pin-10 (which drives LED10) and with a self-contained alarm unit wired in series with its collector. Normally, LED10, Q1 and the alarm are all off, but if LED10 turns on it pulls Q1 on via R2 and thus activates the alarm unit, which indicates the 'over-range' condition.

In this circuit, the alarm unit may take the form of a piezo siren unit that generates an acoustic alarm sound, or a gated astable switch unit that repeatedly switches the LED brightness between high and low levels under the over-range condition, or may be a combination of both of these units. If desired, the unit can be activated by any one of the display LEDs, in which case the alarm will activate whenever that or any higher LED is energised.

TECHNOLOGY WATCH

with Martin Pipe

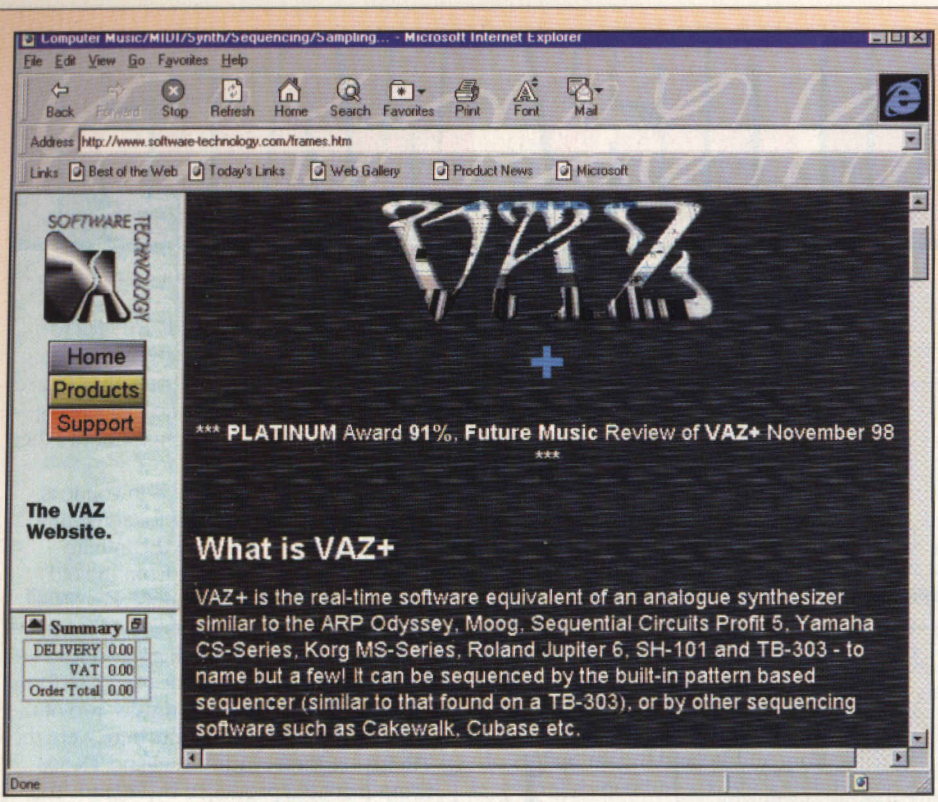
The worlds of computers and electronic music have been intertwined for many years now. First, we saw 8-bit microprocessors being harnessed as control devices in analogue synthesisers, and to provide a user interface. The microprocessors ports drove DACs that fed the synthesisers voltage-controlled filters and oscillators. RAM allowed various combinations of oscillator and filter values – and hence synthesised sounds – to be stored, giving rise to the patches that we now take for granted on modern keyboards. The 1982 introduction of MIDI – an isolated bidirectional serial port and standardised data protocol – was a logical progression. The MIDI data includes information on which sounds to use, which notes to play, and how loud to play each note. Thanks to MIDI, the synthesisers control microprocessors could be networked to other intelligent music devices, such as drum machines, keyboardless synthesisers (tone modules) and sequencers. A sequencer, by the way, can be seen as a multi-track tape recorder for MIDI data. It allows a composition to be built instrument-by-instrument. Interestingly, even some non-music devices – such as lighting rigs – can be controlled via MIDI. The basic implementation of MIDI caters for 16 such channels. Of course, MIDI allows you to play several instruments from the same keyboard – or some other form of controller – which made things a bit easier for travelling musicians.

More recently, digital technology has made major in-roads into the sound creation process. Modern keyboards include lots of DSP chippery to model sounds, and provide some pretty realistic sounds. Of course there's the sampler, which involves the digitisation of real sounds. The pitch of a sample varies, according to the note being played on the keyboard, by reading it out at a faster or slower rate. Sampling, which came to fame in the late 1970s with the Fairlight instrument, is now pretty much taken for granted in pop and experimental music. The Fairlight, when introduced, sold for around £15,000. It could sample a second of 8-bit sound. Todays samplers work with a CD-quality resolution of 16-bits, and are a good deal cheaper. Indeed, many soundcards are capable of being used as samplers in their own right. Terratecs EWS64, for example, loads up a soundbank – PCM samples of particular instruments – when the PC is booted up. Other soundcards, including models from Turtle Beach and Creative Labs, work along similar lines. It is possible to change one or more of the factory samples with ones that you have captured from WAV files. All soundcards have MIDI ports, allowing their synthesisers and samplers to be played by external keyboards. The same ports, coupled with the appropriate software, also allow the PC to be converted into a powerful sequencer.

Some purpose-designed keyboards offer combinations of DSP and sampling – established synthesiser manufacturers like Yamaha, Korg and Roland dream up lots of wonderful new ideas – and names for them – for every new range of products. Some of the better wave-table soundcards employ such techniques. Indeed, one of the latest soundcards from Yamaha – the PCI-bussed SW1000XG – is effectively a PC version of its acclaimed MU20 tone module. Its also considerably cheaper because the PC provides the power supply, case and (software) user interface. The SW1000XG has been designed for expansion, and will accept plug-in cards for DX7 (6-operator FM synthesis, instead of the less-powerful 4-variant built into cheap soundcards) emulation, acoustic synthesis and vocal harmony generation. All pretty neat stuff, it has to be said. Those wanting to make music have never had it so good. Its now possible to construct a bedroom studio around a PC for a relatively small outlay – something that's not lost on the current generation of dance music wannabes. Hell, buy a CD burner and you can even put your tracks onto disc! From idea to finished product without any analogue intervention whatsoever – now that's quite a powerful concept, but one that's being mirrored by an increasing number of other relative disciplines.

Dance music, of course, is in vogue at the moment and has been for some time.. Many such musicians love the infinite variety of sounds possible from the old analogue synthesisers produced by Moog, ARP, Yamaha, Roland, Sequential Circuits and so on. Those out-of-this world lead melodies and deep basslines seem to form a crucial element of such music. Two of the most important instruments here were the TB-303 bassline synthesisers and TR-808 drum machine produced by Roland. The 303 was responsible directly for the acid house sound, while the 808 was deemed influential enough to grace the name of one popular Mancunian dance outfit. Significant amounts of money change hands for such instruments – often far more than the value of the largely off-the-shelf components contained within. The musician will then spend a small fortune on devices that convert MIDI data into a control voltage, so that their newly-acquired vintage equipment can sit comfortably alongside more recent gear. Today, the computer has an answer to this madness in the form of virtual synthesis. PCs have now reached the stage where they are powerful enough to emulate analogue synthesisers in real-time. DSP-based simulation of two or more oscillators, envelope generators, modulators, filters and effects (flanging, chorusing, etc.) is no mean feat – and in most cases you will

Propellerheads RB-338 ReBirth.



The VAZ Website.

need a Pentium 90 or more to achieve it.

The programs that can achieve this deliver their results through the PC soundcard, and many can be played by an external keyboard via the soundcards MIDI port. Such programs feature low latency, so that you don't get an annoying delay between hitting a key and hearing the sound. The first commercial analogue synthesiser emulator to be targetted at dance music creators was Propellerheads RB338 ReBirth, now distributed by Steinberg. A save-disabled demo version of this Swedish software can be downloaded from **http://www.propellerheads.se.** Both Mac and PC versions are available. The MIDI-triggerable ReBirth emulates a 808 drum machine and two 303 synthesisers, and has proved an immense hit with those interested in dance music. The software, which also includes a mixer and delay effects, has a user interface that is closely modelled on the original hardware. The results are superb, with no audible difference from the Roland kit.

Those interested in more conventional analogue synthesis might be interested in VAZ (Virtual Analogue SynthesiZer), which


The Modular Moog.

The VAZ synthesiser.

lives at **http://www.software-technology.com.** From this site, a demo can be downloaded. At under £30, the full version (VAZ+) is rather more affordable than ReBirth, although it does not pretend to do the Roland emulations as well. The highly-customisable VAZ emulates a comprehensive 2-oscillator synthesiser, and includes a decent sequencer and arpeggiator for creating elaborate repeating patterns (hello, Jean Michel Jarre!). VAZ, which requires Windows 95, can be played from an external keyboard via the soundcards MIDI port and can deliver some pretty neat results. The software will run on hardware as humble as a 486DX33, although the sound quality is limited (22kHz sampling) and you are restricted to monophony. A Pentium will allow VAZ to work polyphonically and at a sampling 44.1kHz rate. A modular version of

VAZ is also available – this allows you to build your own synthesiser, but at a much lower price (and floor space) than a Modular Moog! There is much interest in software synthesis, as a search around the Net will reveal. If you have got a PC with Creative Labs AWE32/64 soundcard, why not check out The Retro Sound Virtual Polysynth (RSVP). This shareware program, which costs a mere £10 to register, can be downloaded from **http://www.demonweb.co.uk/c3sys/rsvp.htm.** Its a good deal simpler than VAZ, but is certainly worth experimenting with. The programs author claims that RSVP recreates the random nuances associated with analogue circuits – the apparently carried out extensive analysis of the actual hardware. Drum machine enthusiasts might appreciate a free Windows program, Hammerhead, that can be obtained from **http://inside.hku.nl/~bram/hammer/index.htm.**

Hammer will import sounds, and export your final percussive loops, in WAV format.

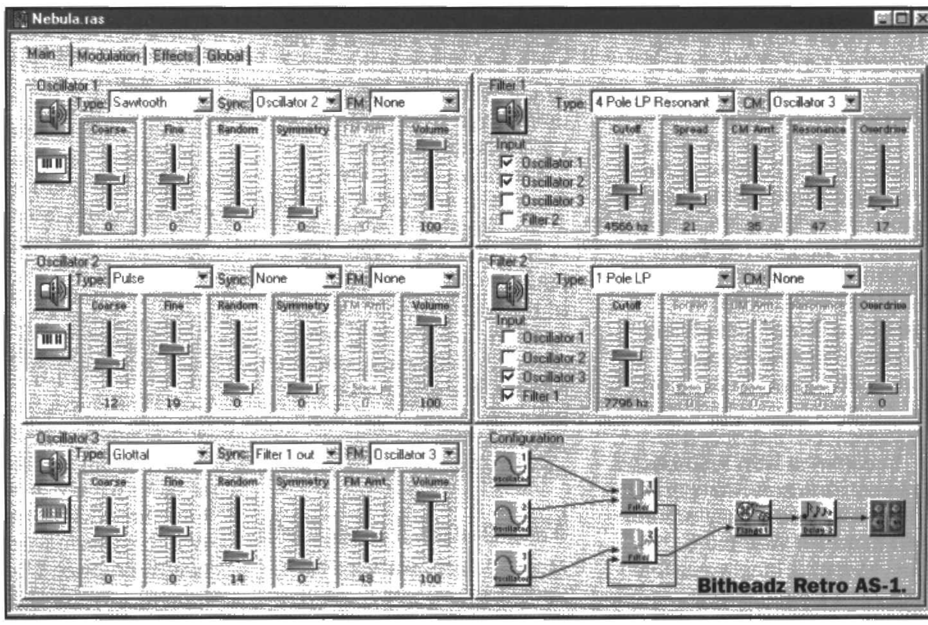

The Mini Moog.

VAZ Sequencer.


Hammerhead Drum Machine.

Moving back to commercial programs, we have Bitheadz Retro AS-1. A time-limited/ save-disabled version of this $259 program can be downloaded from **http://www.bitheadz.com/home.html.** Unfortunately, we had problems retrieving it and the download timed out on at least two occasions. Retros spec looks good – it includes 3 oscillators per voice, 9 waveform types, continuous control of wave form shape, 2 assignable filters per voice, 13 filter types and 16 continuous controllers per voice. There are 2 insert effect processors per voice, 2 global effects processors and an arpeggiator.

Another program of note is Wavecraft, which can be downloaded free of charge from **http://www.cuchulainn.demon.co.uk/wavecraft/.** This Windows program was one of the first virtual synthesisers for personal computers, and will run on modest hardware. Its biggest limitation is that it doesn't generate sounds in real-time – however, you could always save the result as a WAV file and load it into your soundcard. Finally, we have Csound, which can be obtained free-of-charge from **ftp://ftp.maths.bath.ac.uk/pub/dream.**

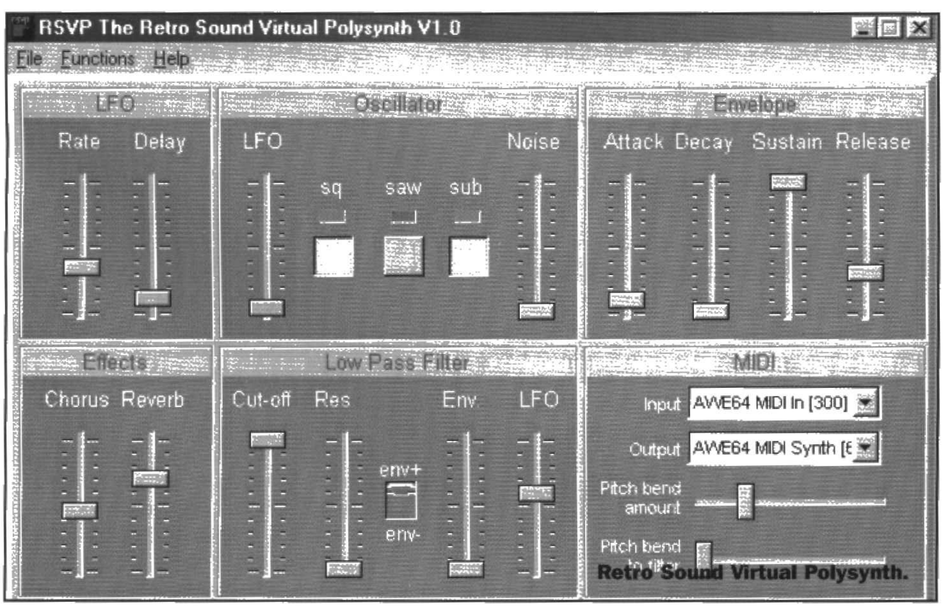


Bitheadz Retro AS-1.

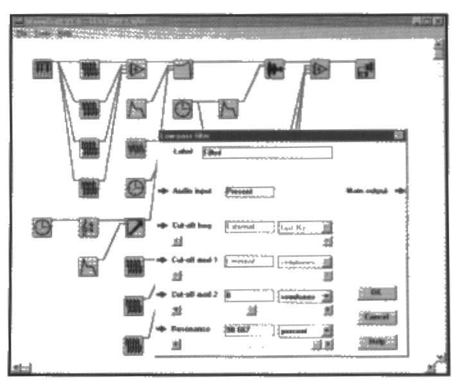
It's available in a variety of forms, including Mac, PC, Atari ST, Archimedes/RISC PC and Unix. This academia-derived program has evolved since the 1960s and is very flexible and powerful. Unfortunately, it is exceedingly difficult to get to grips with – considerable knowledge of music theory and a lot of patience is a great help! Csound, interestingly enough, is covered by some university courses, including a music and sound recording degree at Surrey University and a computer science course at the University of Chicago. There – synthesiser emulation has been recognised by the academics. What greater endorsement can there be?

MP3Man footnote

In an e-mail to Technology Watch, one of our readers points out that the innovative MP3Man featured last month now has a UK distributor. Further details can be found at **http://www.emmpeethree.co.uk.** ELECTRONICS



Retro Sound Virtual Polysynth.


Wavecraft - one of the first virtual synthesizers for PCs.

E-mail your comments or suggestions to Martin Pipe at whatnet@cix.compulink.co.uk. – Or look out for him online! His ICQ ID is: 15482544

CompuServe 2000

Lookout for a brand-new appearance to the CompuServe network in the near future. CompuServe launches its new client application CompuServe 2000 shortly, heralding it as a next-generation online Internet service. In the process, CompuServe will be upgrading its capabilities considerably. For instance, the client will finally allow multiple email addresses, allowing up to five associated users to have a mailbox each on a single account, with a total of 10Mb of Web storage space. Other online Internet services have had this facility for a while but CompuServe was awaiting its network restructuring, which is now in place and ready to support the consequent upgrade.

Other new features which CompuServe 2000 will give include an Instant Messenger system which lets you know when friends, family and colleagues are online, enabling you to chat in real-time. Email scheduling is much enhanced, and email attachments are now automatically and intelligently compressed and encoded.

In common with Web-based Internet standards, CompuServe 2000 is based totally around HTML as the Web page programming language. That means it is completely standard in operation. Prior clients were based on a separately operating front-end, even though HTML Web pages were accessed as and when required. That means, quite logically – if readers are already one step ahead – that the service operates just as a normal Web browser, with users accessing Web pages as links from other service parts.

For the record, CompuServe 2000 is based around Microsoft' Internet Explorer 4 Web browser, which has been adapted to create a common CompuServe appearance, with the result that the service provides a unified interface wherever you are on the CompuServe network. So, for the first time within the CompuServe network, there aren't different appearances depending on what you're doing. This will have the twin advantages of allowing new users to feel more at home much more quickly, while ensuring that even the most demanding of users can take full advantage of CompuServe's considerable power.

The new client software CompuServe 2000 is currently in beta testing stages (we obviously can't divulge its secrets in too great a detail at the moment, but we can confirm that it's fairly stable and extremely nice), and final release is expected shortly. We'll be taking a closer look at CompuServe 2000 as it moves towards public display.

Microsoft Falls Foul

Most readers will already know that Microsoft is in deep water in the US, where the Department of Justice has taken out an anti-trust case against Microsoft's working practices, which it says are anti-competitive. According to the Department of Justice, Microsoft has used improper and unfair tactics to make sure its Internet Explorer Web browser is used on PCs before its rival Web browser Navigator from Netscape. At the time of writing, Microsoft's case is looking pretty rocky. However, these things are difficult (well, OK, impossible) to predict and it's likely that Microsoft will come out with all guns blazing before the trial reaches a conclusion. Nevertheless, whatever happens, the computing community is likely to face significant upheaval when the case ends. If the Department of Justice wins, Microsoft will be legally required to be more fair in its dealing with third-parties, which should be good news for Microsoft competitors. If Microsoft wins, on the other hand, its working practices will be effectively certified as acceptable, so it will go from strength to strength.

However, in the meantime, another rival-Sun Microsystems – has taken its own legal steps against Microsoft. And the consequences of this court case could be just as wide-ranging as the Department of Justice anti-trust suit. Sun Microsystems developed and licences the Java programming language that is used widely around the Internet and beyond. Most Web browsers (certainly the two main ones Microsoft Internet Explorer and Netscape Navigator) these days incorporate Java.

There's good reasoning behind this. The whole point about Java is that it's a universal programming language, so that it (the language) and its programs (commonly called applets) can be used on any computer, on any computer operating system, and within any Java-enabled application. Sun Microsystems ensures this by closely defining a specification for compatibility. However, Microsoft has built its own extensions to the Java programming language such that Java applets written using Microsoft Java extensions will really be fully playable only on – you've guessed it – Microsoft operating systems (that is, Windows) and Microsoft applications. Of course, this defeats the object of Java, which Sun Microsystems always intended to be a universal and open product.

So Sun Microsystems has taken Microsoft to court. And, in a preliminary hearing, the US federal district court judge Ronald Whyte has agreed that Sun Microsystems is right to do so, ordering Microsoft to alter Windows to either pass Sun Microsystem's compatibility test for Java, or take Java out of Windows. The grace period to comply with this order is 90 days – the middle of February.

Exactly where this gets us all remains to be seen. If Microsoft makes its Java features Sun Microsystems-compatible then all will be as intended. The opposite side of the coin though, could be that Microsoft merely removes support for Java altogether. As Microsoft effectively commands most computer desktops in the world the aftermath of the latter course of action could be quite a shockwave. We'll keep readers posted.

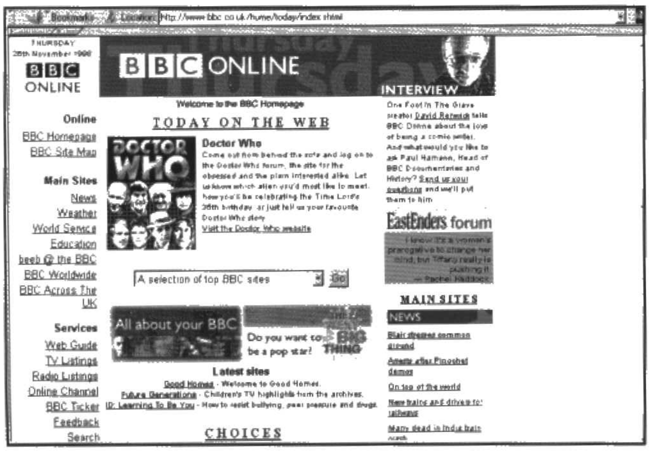
Liquid Audio Unveils Watermarking Technology to Combat Piracy

Liquid Audio at **<www.liquidaudio.com>** has developed a digital watermarking technology to meet the needs of the music industry for preventing music piracy on the Internet. The new Liquid Watermark, provides performing rights agencies, record labels, music publishers, recording artists and composers with a simple way to identify, authenticate and protect their musical recordings and other audio-based intellectual property.

The Liquid Watermark allows content owners to embed inaudible security information within a recording to help prevent piracy. Since the Liquid Watermark is an integral part of a recording, it travels with the audio regardless of its medium or carrier. To help prevent and detect piracy, a song or CD with the Liquid Watermark can be decoded during playback to identify bootleg copies of a recording.

Even if the recording is copied to CD, analogue tape or transmitted over the Internet, the Liquid Watermark remains with the music and is readily accessible whenever suspected pirate copies appear. Unlike other watermarking systems that were designed to work with uncompressed audio, the Liquid Watermark was designed from the ground up to work with encoded audio formats like MPEG AAC and Dolby Digital, as well as linear audio.

BBC Tops UK Net charts



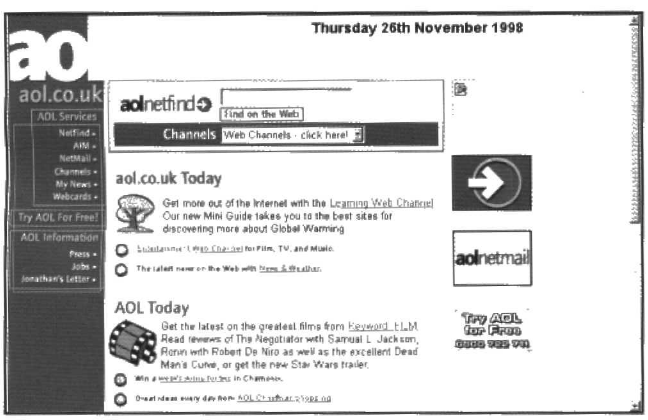
BBC Online at **<www.bbc.co.uk>** has been confirmed as the most visited Web site in the UK, according to new independent figures.

The BBC had a total of 46,600,000 page views across bbc.co.uk and beeb@the BBC sites – as audited by ABC//electronic for the month of October. Among the sites trailing behind the BBC were Yahoo, Soccernet and the Electronic Telegraph.

The award-winning BBC News site registered almost as many page views as the rest of the BBC online offering – just over 20,000,000. The news site attracted around a million page views a day during major events such as the recent Leonid meteor storm, release of the Starr report and the UK Budget.

At the beginning of November, the UK Government gave the BBC the go-ahead to put its Internet services on a permanent footing as a core, publicly funded service alongside television and radio.

AOL Acquires Netscape



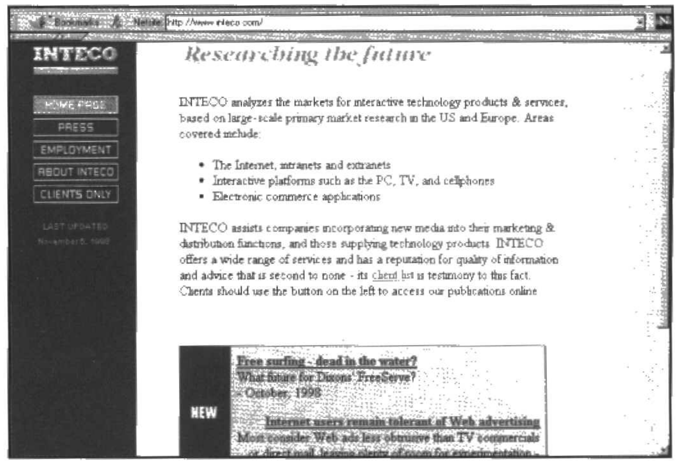
The big news in the online world last month was the announcement by AOL at **<www.aol.com>** that it is set to acquire Netscape at **<www.netscape.com>** in a deal that is set to extend AOL's leadership in interactive services. The deal will substantially broaden AOL's global audience at home and at work, by adding the fast-growing Netscape Netcenter portal that is integrated within the Netscape browser environment.

With Netscape joining its AOL, CompuServe, AOL.COM, AOL Instant Messenger, ICQ, and Digital City brands, AOL is set to operate the most popular and diverse family of brands in the online world.

The Netscape brand is virtually synonymous with the Internet, including such widely used products as Netscape's browser, Netscape Netcenter, and Netscape's suite of enterprise and e-commerce applications and software.

AOL will be able to efficiently speed the development of Netscape's products and services with its shared infrastructure, current advertising and commerce relationships, and ability to drive traffic from its other brands.

Free Surfing – Dead in the Water?



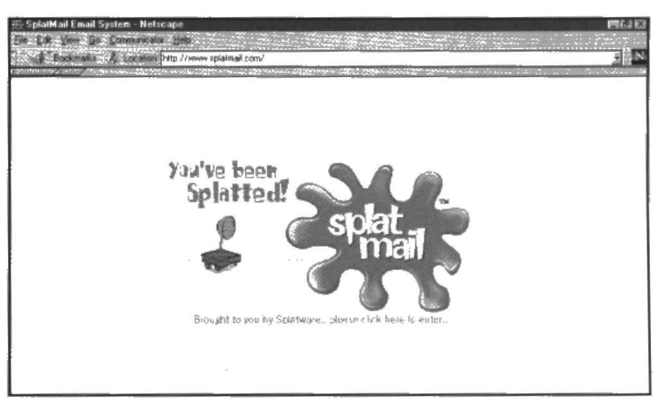
Dixons has recently announced a free Internet access service, but with telephone support at a pound per minute. How will this be received by existing Internet users and by those who are not yet online? INTECO's recent series of in-depth focus groups with home and workplace Internet users helps answer these questions.

The majority of home Internet users interviewed by INTECO at **<www.inteco.com>** considered their current subscription good value for money, but the telephone bill was obviously a major problem. Generally they were not interested in free access funded by advertising due to the time and money that would be wasted waiting for the adverts to load. This hostility toward advertising-supported services serves as a warning to any provider expecting to finance such a venture by promoting its retail channels in an obtrusive manner.

It is clear that there is a limit to the success that 'free' services can achieve. Some light users may believe the money they save from not paying a monthly fee will make it worthwhile switching. However, such users are not very attractive to purveyors of free services – whose business model relies on high usage to extract portal fees and generate revenue from telephony charges.

Heavier users find existing subscription fees reasonable and are even prepared to pay more for a faster service. To capture and retain these users a free service provider would have to invest sufficiently to beat more traditional ISPs on technical and quality of service grounds – not on price alone – and this also means providing good support.

SplatMail Enhances E-Mail



Start-up software company Splatware has launched SplatMail – an email and personal note application which transforms plain text emails into lively messages that are fun to send and receive. SplatMail allows users to personalise messages using SplatNotes – on-screen-graphical notes that are like real bits of paper. Check **<www.splatmail.com>** for a free 15-day trail of the product.

World's First 'Information Tracker' Demonstrated

Did you ever wish you had an automatic assistant that could organise and file everything on your computer, so that you could always find exactly what you need, when you need it?

Life is easier when you keep track of it with Enfish Tracker Pro, a new software program for Windows 95, 98 and NT PCs that organises, finds and keeps track of information – automatically.

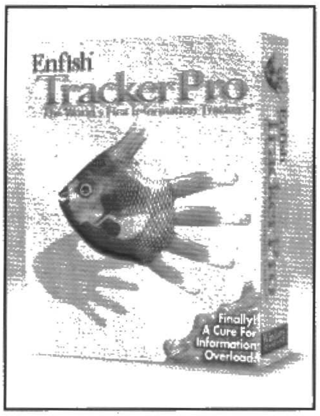
To enable as people to try this groundbreaking new software product, PC users can download Enfish Tracker Pro at **<www.enfish.com/download/trial>** and try it free for 45 days.

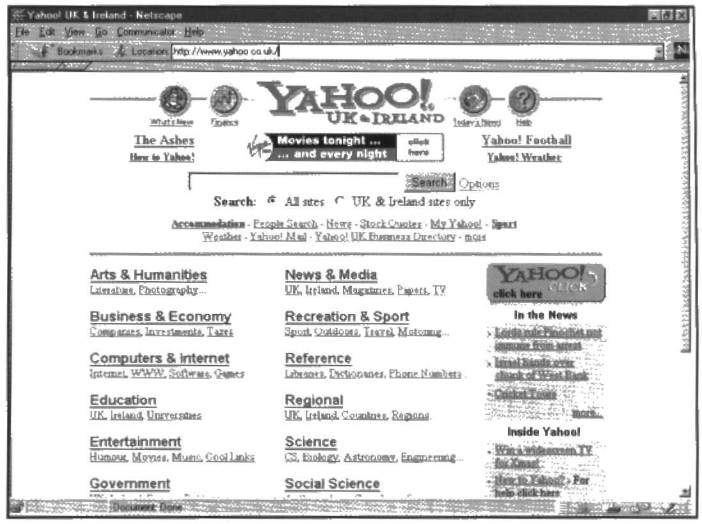
The key concept behind Enfish Tracker Pro is the Tracker – a new, dynamic way to automatically organise and instantly locate your information. A Tracker is like a personal assistant that automatically monitors all of your information sources, reads new information as it arrives, organises it in all the right places and alerts you to what's new.

A Tracker can automatically prioritise documents and email, find new or missing information or even do research and find things on the Web.

Instead of manually dragging icons into file folders, or manually searching for information, you just set up a Tracker in advance using the Enfish Tracker Wizard. Simply specify words, phrases and instructions that tell the Tracker what you're looking for.

The Tracker constantly watches for new information that matches your personal interests in the documents, e-mail, newsletters, Intranet and Internet Web sites you choose to monitor. That way you always have the latest information without having to find it yourself.





Yahoo! Mail comes to UK & Ireland

Yahoo! at **<www.yahoo.co.uk>** has launched a localised Yahoo! Mail service for UK and Irish users at mail.yahoo.co.uk. Yahoo! Mail provides users with a free e-mail account accessible from any Internet connected computer.

Global Internet is ISP of the Year

Global Internet at **<www.global.net.uk>** has been named ISP of the year by Internet Magazine. The publication, which tracks the performance of ISPs on an ongoing basis, tested thirty competitors for value for money, technical support, installation and performance.

Global Internet won the highest overall mark for its consistent performance across all four of the test categories. Well-known names such as Demon, VirginNet, BT Internet, UUNet and Cable & Wireless Internet were amongst the runners-up.

Over a Million UK Adults Joined the Web in the Last Six Months

Adult Web usage has increased from 5,900,000 (13% of the UK adult population) to 7,000,000 (15%) in the last six months, according to the InternetTrak survey at **<www.ziffdavis.com/marketresearch>.**

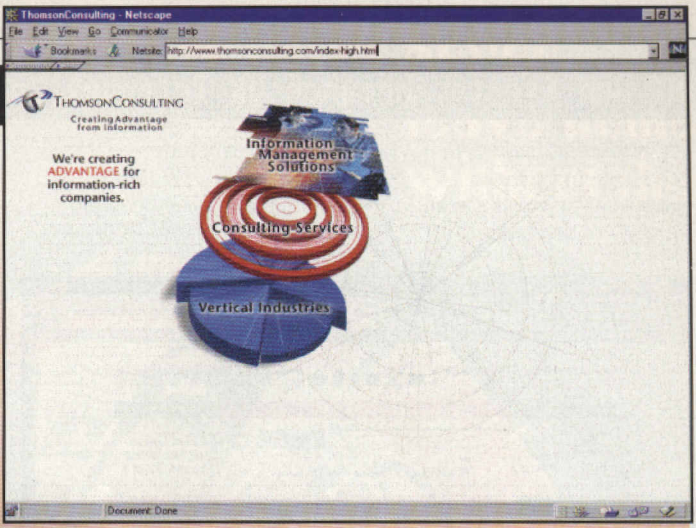
The second wave of this ongoing study, commissioned by Ziff-Davis, Yahoo! and Dell, also looked for the first time at patterns of usage amongst 14 to 17 year olds. This group accounts for a further one million users, taking penetration amongst the population over 14 to 17%. Web usage in the 14 to 17 age group is likely to be bolstered over the coming months as initiatives such as the Government's National Grid for Learning programme encourage a deeper penetration of Internet access within the education sector.

As highlighted in the first wave of the survey, the proportion of women joining the Web continues to increase. A mere 14% of those who first used the Web two years ago are women, while 40% of users who started using the Web in the last three months are female. This shift towards women is further reflected by 14 to 17 year old users, where 47% are female, and in the number of respondents planning to use the Web in the next six months – of 1,800,000 expressing this intention, 57% are women.

InternetTrak also reveals how different demographic groups are using the Net, reflecting the diversity of content and services available online. Amongst the younger age groups, chat, games, news, music, and sport content are popular whilst the older age groups spend most time finding information on news, stocks and shares, and personal finance. Researching information on clothing and to help with homework is important to the 14 to 17 year old group. Those in the 18 to 54 age range most frequently use the Web to help with their jobs and to find information about computers, software, and travel.

Online shopping continues to grow in popularity. The convenience of 24 hour, year-round shopping is attracting many to use the Web to purchase goods. The number of people gathering information on selected products prior to purchasing online and offline has risen from 2,000,000 to 3,300,000 in the last six months. Popular merchandise purchased on the Internet range from computers and related products through to software, music CDs and travel services.

Web Content is King



Thomson Consulting has launched a White Paper which details the potential for new technology within the publishing industry and the implications for those companies unprepared to adopt it. The White Paper can be downloaded from the Web site at **<www.thomsonconsulting.com>**.

The paper has been developed in response to industry research, which highlights that, despite potential gains, there is resistance to technological change among publishing corporations.

In particular, it highlights the growing importance of content-centricity in Web commerce that will be brought about with the use of Internet technologies, in particular, XML. Most applications on the Web are still written in product-centric languages such as HTML, which constrains later redeployment of data.

Entitled 'Forget Electronic Publishing!', the paper is designed to guide publishers and Web authors through the latest developments. It focuses on the most common causes of project failure, and offers advice on how pubiishers can minimise the financial risks of investment in this area.

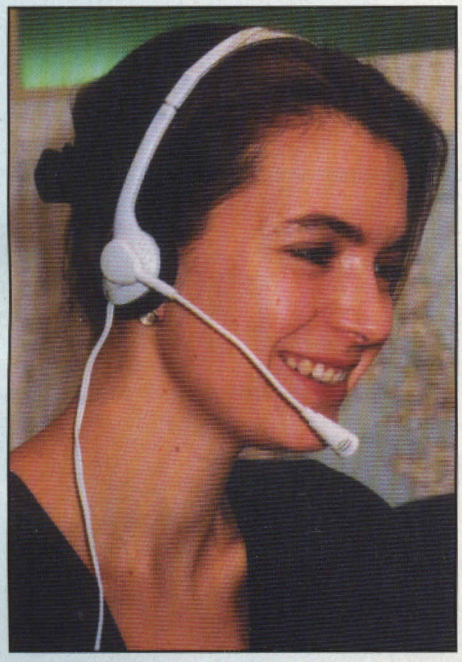
amazon.com, PowerGen and Barnes & Noble are among the examples shown, where e-commerce has been used to significantly increase revenues and reduce costs by facilitating the 'repurposing' of Web-based data.

UK Company Calls Via the Internet

An enterprising marketing communications agency has become the first UK business to put its international phone traffic over the Internet, shaving its communications bills by up to 75%.

Rainier at **<www.rainierco.co.uk>**, an international marketing communications agency serving the hi-tech sector, has its head office in Princeton, Massachusetts, US. It has taken the step of using Internet telephony for all phone calls outside the UK.

The Internet has been recognised as a potential communications medium for global voice traffic for several years. But despite the technology being available free, no other UK companies have yet had the confidence to use it as their main international call service.

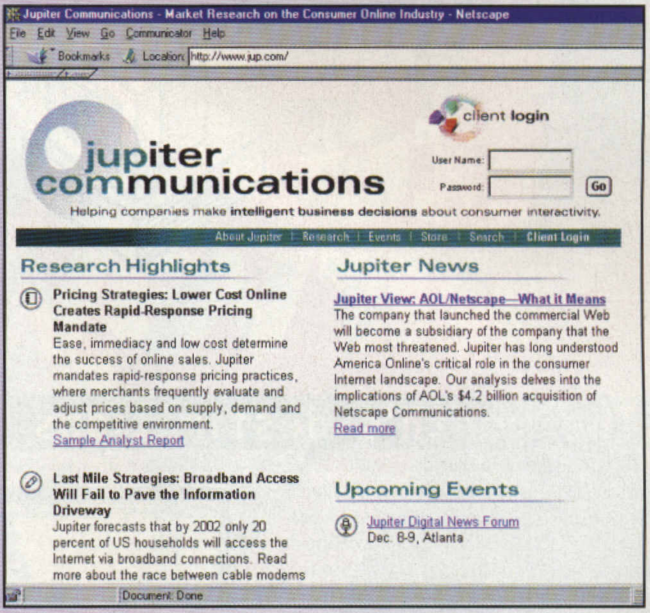


Rainier staff say that it is exactly like making a regular telephone call and is difficult to tell that the call is being placed over the Internet. At worst there is a quarter-second delay, similar to making a call over a satellite link. Even in these cases the voice quality at either end is good.

Instead of the traditional push button handset, Rainier executives use a 'virtual' telephone on their PCs together with a combined headphone and microphone headset for making all inter-company and non-critical international calls. Like a regular phone service, calls are received directly at telephone handsets, so recipients may not realise that the call is via the Internet.

The Internet telephony software that runs on each of the executive's PCs is supplied free from IDT and can be downloaded from the company's Internet telephony Web site at **<www.net2phone.com>**.

Consumers Place Trust in Online News



A new survey shows that more than 80 % of online consumers trust online news as much as they trust newspapers, broadcast television, and cable news outlets, and an additional 7% view online news as more reliable than other mediums, according to a report released by Jupiter Communications at **<www.jup.com>**.

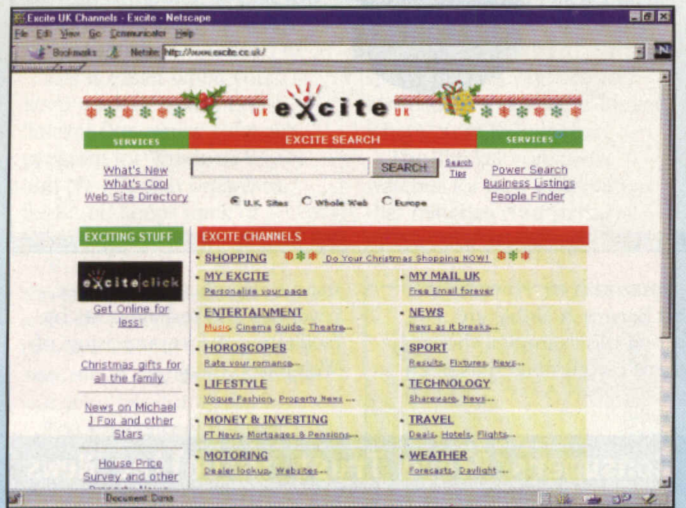
The report, for which more than 2,200 online consumers were surveyed, also found that consumers' trust goes beyond news accuracy. Most consumers do not question the editorial integrity of online news providers that engage in commerce initiatives.

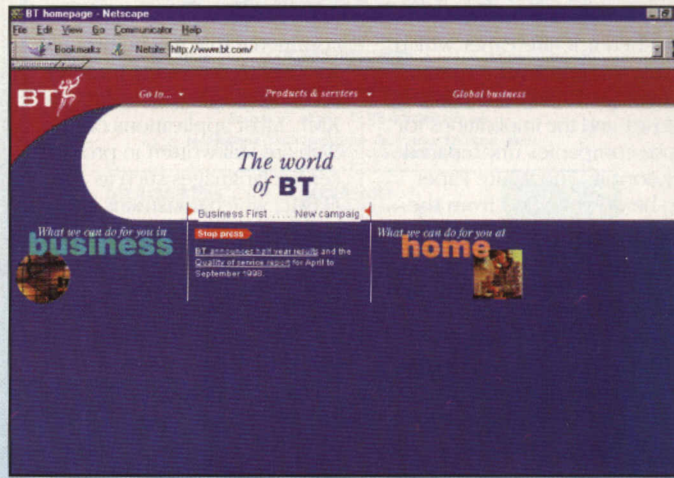
For instance, consumers can accept that a news site's review of a new CD is followed by a button allowing online visitors to purchase that CD via a third-party e-commerce vendor. In fact, nearly 70% of online news consumers polled are unconcerned about the objectivity of news sources that also sell goods online.

The report indicates that consumers' trust and acceptance with these issues will help news publishers navigate the increasingly uneasy revenue waters by offering a second revenue stream to help support their growing Internet businesses. Jupiter encourages news providers to be more aggressive in developing contextual commerce links to corresponding editorial content.

BT and Excite Announce UK Internet Initiative

BT at **<www.bt.com>** is to buy a 50% stake in Excite at **<www.excite.co.uk>** in an agreement that is set to develop BT's presence in Internet advertising and transactions. The deal also brings the benefits of Excite's



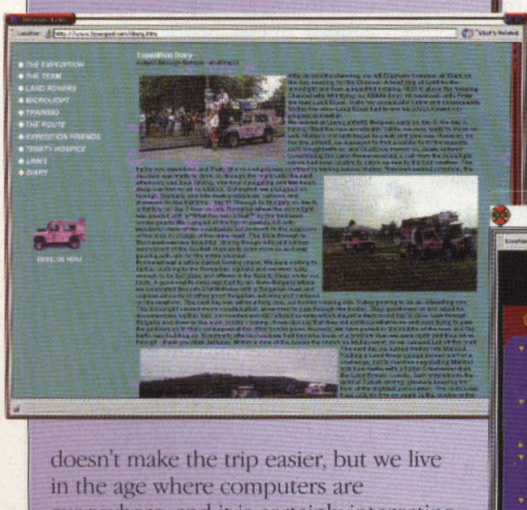


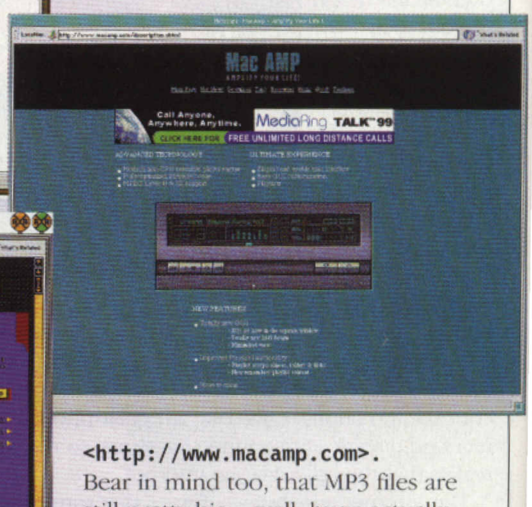
considerable Internet technology and, specifically, its online marketing and sales expertise. Excite UK will benefit through better access to one of Europe's most important and fastest growing Internet markets and BT's expertise in further localising its product to the UK market.

Site Survey

The month's destinations

Overlanding has always been popular with people driving a range of vehicles all over the world. This has often been done in the past with just a compass and a change of clothes. The London to Sydney Overland Expedition is doing it with technology. This technology may not be necessary, and it certainly





doesn't make the trip easier, but we live in the age where computers are everywhere, and it is certainly interesting travelling with a wide variety of technology. The expedition has a Web site at: **<http://www.1soexped.com>** that details the expedition as it goes around the world on its journey. Agfa has sponsored the expedition with ePhoto 1280 cameras, that allow photographs of events to be taken and displayed on the Web site virtually as the events occur.

One of the buzzwords going around the Internet at the moment is MP3 (that stands for: motion picture engineering group – MPEG – layer 3, for those who don't know). It's a file compression format, for multimedia files, that has been embraced by the underground music community as a means of transferring sound files of good quality over the Internet. Several new bands, and some established ones, are experimenting with MP3 with an aim to producing music samples for free distribution over the Internet. The first UK band to produce a full album of MP3 tracks is Donbingo, whose debut album is available in its entirety off the Internet. Check it out, at: **<http://www.musicbank.net/donbingo>**. Bear in mind you'll need an MP3 player for your computer – try WinAMP for PCs, from **<http://www.winamp.com>**, or MacAMP for Macs, from **<http://www.macamp.com>**. Bear in mind too, that MP3 files are still pretty big – well, huge actually – despite being less than around a tenth of their CD counterparts, so expect long download times.